FLORIDA SEA GRANT PROGRAM

FORT PIERCE INLET
Glossary of Inlets Report #2

by Todd L. Walton

Report Number 3 July 1974

TABLE OF CONTENTS

FOREWORD

The numerous inlets connecting Florida's inner waters to the Atlantic Ocean and Gulf of Mexico are important from considerations of recreational and commercial vessel traffic and also provide small boat access to safe refuge during unexpected severe weather and waves. In addition, inlets act as flushing agents, providing renewal of bay waters by exchange with outer continental shelf waters. Unfortunately, inlets also contribute significantly to the serious beach erosion problem prevalent along most of Florida's shoreline. The complexities of the hydraulic and sediment transport mechanics in the vicinity of inlets present a formidable challenge to engineers and scientists.

The factors noted, along with the interesting historical role that inlets have played in the early development of Florida have resulted in considerable documentation pertaining to the major inlets of the State.

This report of Ft. Pierce Inlet is the second in a "Glossary of Inlets" series to be prepared under the State University System Sea Grant Project "Nearshore Circulation, Littoral Drift, and the Sand Budget of Florida". The purpose of this series is for each inlet to provide a summary of the more significant available information and to list known documentation. It is hoped that this series will yield an improved understanding of the overall effect of each inlet on the economics, recreation, water quality, and shoreline stability of the surrounding area. The proper future management, use, and control of Florida inlets will require an appreciation of the evolution and past response of the inlet and considerable future study.

ACKNOWLEDGMENTS

Appreciation is extended to the many people whose time and efforts contributed to the historical information presented in this report. Special thanks go to Miss E. Alexander and Mrs. H. Tilden of the P. K. Yonge Library of Florida History, Gainesville, Florida; Mrs. Bearden and Mrs. Arana of the St. Augustine Historical Association, St. Augustine, Florida; Mr. Weldon Lewis, County Administrator of St. Lucie County, Ft. Pierce, Florida; and Col. M. A. Ramsey (Retd.) of Fort Pierce, Florida.

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INTRODUCTION

Ft. Pierce Inlet is a man-made opening from the Atlantic Ocean into the Indian River on the east coast of Florida, east of the town of Fort Pierce, Florida (population 25,296 as of 1960). The town and inlet derive their present names from a U.S. Army fort established there during the Seminole Indian Wars of the 1830's. The inlet can be found on National Ocean Survey (formerly U.S. Coast and Geodetic Survey) Charts, Nos. 845SC, 1112, 1247, and U.S. Geological Survey Chart "Fort Pierce" 1949 - (70 PR). Detailed hydrographic surveys of the area are available on National Ocean Survey (U.S.C. & G.S) Hydrographic Survey Charts Nos.: H-1523a (1883), H-1513b (1883 - Indian River inside inlet), H-1570 (1883 - Indian River inside inlet), H-5025 (1930), and H-5027 (1930). A portion of NOS (National Ocean Survey) Chart 1247 is shown in Figure 1 for reference to areas mentioned in this report.

Geography and Geology

The tributary area of Ft. Pierce Inlet is primarily devoted to agriculture, cattle raising, trade and distribution, and commerical and sport fishing. Agricultural products include citrus fruits, tomatoes, and winter vegetables. The majority of the waterfront land surrounding the inlet and the Indian River in the vicinity of the inlet is utilized by fishing, tourist, and development interests. Detailed characteristics of the economy of the Fort Pierce area can be found in Reference 1.

To the north of Fort Pierce Inlet lies a long stretch of barrier island. This barrier extends unbreached to Sebastian Inlet, 29 miles north of Fort

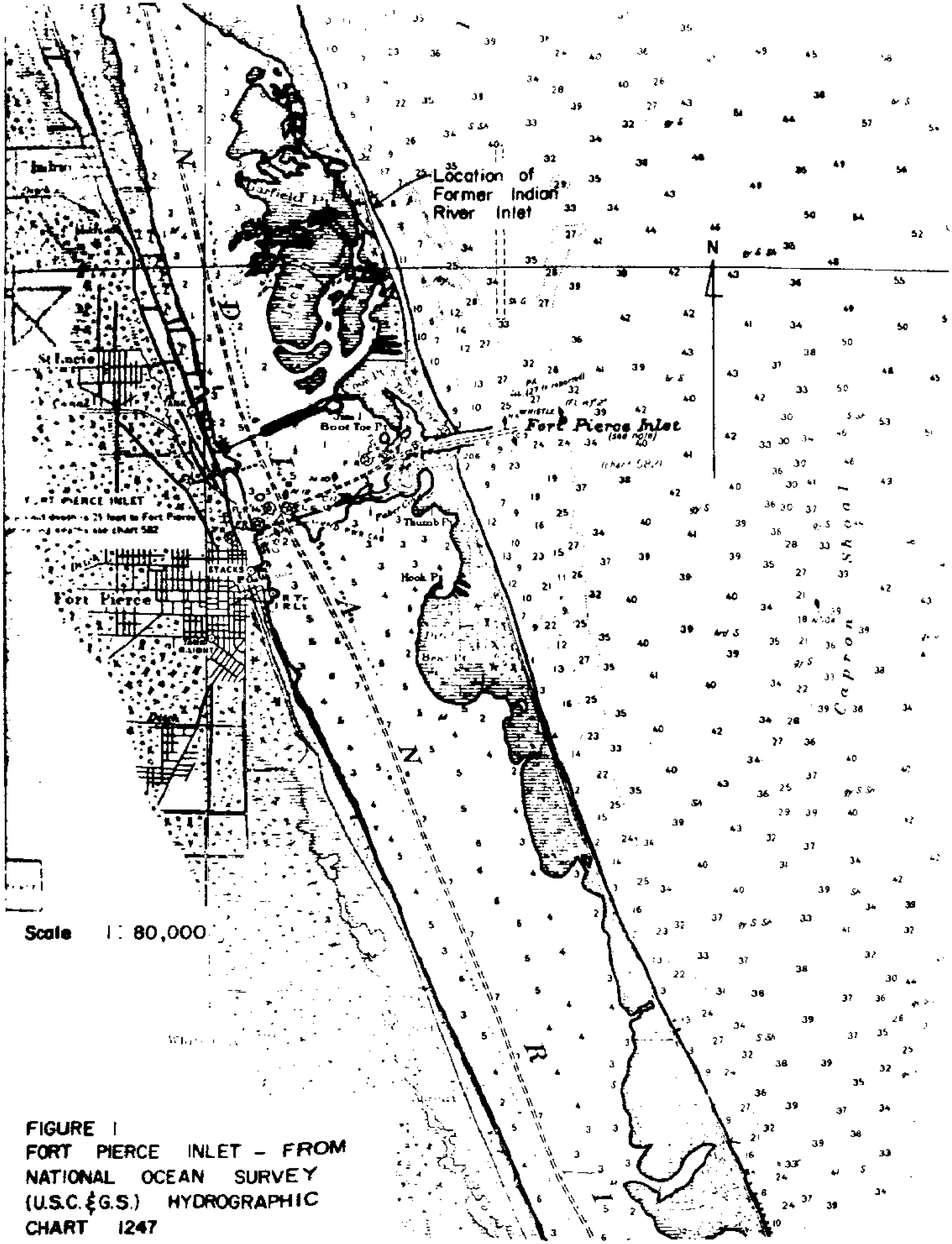

FIGURE I
FORT PIERCE INLET – FROM
NATIONAL OCEAN SURVEY
(U.S.C.&G.S.) HYDROGRAPHIC
CHART 1247

Pierce. On the barrier, a dune line exists 10 to 15 feet in height continuously from Sebastian Inlet to Fort Pierce Inlet. The width of the barrier varies from 150 feet to 1.3 miles in this reach, with an average width of approximately 1000-2000 feet. Even in the narrowest sections of the barrier island, though, the dunes present a formidable obstacle to the oceans. The beach immediately north of the inlet is 200-300 feet wide and very low. The seaward face of the dune is very steep. The lagoon side of the barrier is quite low also, about 50% lies below the 5 ft. mean sea level contour. Landward of the barrier island is Indian River, a typical east coast barrier island lagoon.

Geologists speculate that the barrier island and lagoon system on Florida's east coast was formed following or concurrent with one of the last of four periods of emergence evident in Florida, at which time there was a tilting of the plateau about its longitudinal axis. The west coast was partially submerged, as indicated by the wide estuaries and offshore channels of its streams, while the east coast was correspondingly elevated. The barrier islands are thought to be part of an ancient offshore bar which was elevated above sea level and further built up by wave and wind action.

Approximately 1/2 to 2 miles westward of the lagoon, ancient sandhills 20-30 feet in height continuously parallel the coast. These high sand hills of the coastal ridge are sand dunes built upon old beach ridges formed during the Pleistocene epoch and represent an ancient shoreline, possibly of the Silver Bluff or Pamlico times.

Hutchinson Island lies to the south of Fort Pierce Inlet, extending approximately 21 miles southward to the next break in the barrier system at St. Lucie Inlet. The first 7 miles of the barrier island south of Fort Pierce are very low and susceptible to flooding (Reference 2). The elevation of the highway traversing the area is, in most places, under 5 feet MSL. The barrier beach in this 7 mile section of Hutchinson Island is influenced strongly by the inlet and is very narrow except for the 1.3 miles of recently restored beach just south of the inlet. There is no dune line as such in this area, although a reasonably heavy growth of sea strand vegetation thrives landward of ordinary wave action. Low dunes start approximately 1-2 miles south of the south jetty and gradually increase in elevation, progressing southward.

South of this 7 mile limit, a normal dune line resumes 10 to 15 feet in height to within 3 miles of St. Lucie Inlet. The seaward face of the dune is steep and the beach is low. This section of shoreline is undeveloped for the most part, and mangroves are numerous along the barrier island and in shallow sections of the lagoon (Indian River). West of the lagoon 2000 to 3000 feet, the ancient sandhills continue to parallel the coast varying in height from 25 to 35 feet.

The Fort Pierce area is underlain by the Anastasia formation consisting of coarse sandstone composed of consolidated coral sand and coquina, and is covered by a thin veneer of Pamlico sands.

Coquina rock appears at several places as a submerged reef that generally parallels the shoreline at various distances offshore, from highwater line to 2500 ft. seaward. The coquina reefs dissipate a portion of the ocean's energy before reaching the beach, and thus help to retard the rate of shoreline erosion. Also the disintegration of the coquina provides a source of beach material for the area.

HISTORY OF INLET

Long before the existence of the present Fort Pierce Inlet, a natural inlet existed 2.7 miles to the north. This earlier inlet was mentioned in a description of the Florida East Coast by Alvaro Mexia, an early Spanish explorer, in 1605, and is shown on his map of the same date. It may be inferred from his description that the inlet was very shallow:

> "Y luego vira al este y sale a la mar por la dicha barra de Ayrz" (translated: "and then veers to the east and flows out to sea over the Bar of Ais").

Early maps in the 1700's show the inlet by the name Ay's Inlet, which is the name Mexica gave it relating to the fierce tribe of oceanic dwelling Ays (Aies) Indians which lived in the area.

Apparently some confusion over the inlet's name existed in its early history as it was also referred to as Hillsborough Inlet or Indian Inlet. An English map dated 1765 by Wm. Gerard De Brahm, His Majesty's Surveyor General, shows the inlet by its three names: Hillsborough, Indian, and Ay's Inlet, and shows a narrow channel existing through the barrier.

De Brahm's description of the inlet is as follows (Reference 3):

> "The tenth Inlet is to the Southward of Cape Canaveral, called Hillsborough, alias Indian, alias Ays Inlet, situated in Latitude 27°30'53" and 1°1'18½" East of Saint Augustin or 1°12'22" East of St. Mary's, has two Bars; the first had anno 1765 (when I recognized [reconnoitered] it) five Channels, the second from the North had 18, and the second from the South had 12 feet; the second Bar had 2 Channels to the South and 2 Swashes to the North.
>
> The Tide rose 4 feet the 12th of March, which was two days before Neep Tide. I entered the Harbour in my Boat, had 12 feet, near high Water in the second Channel, from the South on the first Bar, and in the South Channel of the second Bar I had 5 feet, when another of my Boats entering the North Channel of the second Bar had 6 feet Water. This Inlet is 1,500 Links wide from its North to its South Point; is to

> this day frequented by Spanish-fishing Schooners from Cuba, the South Hillsborough, alias Ays Stream, and Huntingdon, alias Santa Luz, River are famous for Mullets and Bass. Upon which Stream and River they send their Boasts, and leave their Schooner in the Harbour, from whence they do not return to Cuba before the Schooner is laden with Fish; these Schooners have sometimes been obliged to wait several Weeks, the Bars Channel being shut up by Easterly Gales, until they could go out with the first Ebb at full or change soon after these Gales; for although they shut up the Channel, yet they flood constantly the Sea Water in the Harbour, and admit of no Ebb, of course restore in Water the Obstruction, which they cause unto Navigation, by filling the .. rs Channels.

Toward the latter 1800's, the inlet was referred to consistently as Indian River Inlet. United States Coast and Geodetic Survey Charts H-1523a and H-1513b both show the old inlet and portions of these charts have been reproduced in the appendix of this report as Figures A-2 and A-3.

In its early years, the inlet channel shifted frequently as do many uncontrolled inlets on coasts where littoral drift is substantial. Apparently the inlet stayed navigable for small schooners and fishing boats until the early 1900's when the inlet began to shoal to such an extent that fishing boats and other vessels could not use it. The shoaling problem experienced in this period is undoubtedly due to the opening of the St. Lucie Inlet in 1892, which as it widened in early years, took much of the tidal flow from the Indian River Inlet.

In April 1916, a War Department permit was requested by local interests to dredge an inlet between the Atlantic Ocean and the Indian River at Fort Pierce. Local interests undoubtedly believed that the inlet would expand as St. Lucie Inlet, 21 miles to the south, had in its early stages. This permit was denied; the reason for its denial is unknown.

In the late 1800's and early 1900's, considerable rivalry existed between the coastal communities of the lower Florida East Coast vying for the shipping commerce trade. After the creation of the St. Lucie Inlet, local interests in the vicinity of Port Sewall and Stuart tried vainly to secure federal aid for the establishment of a port in conjunction with the St. Lucie Inlet. Years passed, and four attempts to establish a harbor at Port Sewall with federal money failed (see River and Harbor Acts of 1894, 1896, 1907, and 1911).

The local interests in the Fort Pierce area, profiting by Port Sewall's experience created a Fort Pierce Inlet District to finance the creation of a new inlet without Federal help. The Fort Pierce Inlet District, a special taxing district created by the State Legislature, was established in 1918, comprising most of the present area of St. Lucie County. Over a ten year period, a total of 1,850,000 dollars was raised by the District through the issue of bonds. The total proceeds were expended during the period 1920 through 1929 to excavate a channel from deep water in the ocean through the barrier island, and across the Indian River to a turning basin at Fort Pierce, and to build protecting jetties for the inlet.

Work on the original channel was begun in 1920. Photographs of the Dredge Tuscawilla making the cut through the barrier island, and of the inlet prior to and after the final cut are shown in Appendix V, Figures A4 and A5. The final cut through the barrier was made on May 8, 1921. At the time of the final cut, the dredge was washed completely across the Indian River by the strong flow of ocean water surging into the cut. The channel was originally 4 feet deep and 100 feet wide and protected by rock jetties of native coquina rock weighing about 130 lbs. per cubic foot, 400 feet long and 600[a] feet apart constructed prior to the cut. The strong tidal currents rapidly scoured the channel to a depth of 12 feet in places and widened the inlet.

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[a]Jetty spacing figure quoted from Reference 5 is in question. The jetty spacing may have been 900 feet.

The jetties were apparently too far apart for their length as stated in Reference 5, and storm waves battered the channel banks, gouging large areas out of the inlet's side banks. This action isolated the jetties, and they had to be modified somewhat by lengthening and by revetting the inlet's banks with coquina rock. Present day alignment difference between the south jetty and its revetment is due to the fact that the banks were revetted as they existed after the storm waves had destroyed a portion of the inlet's south bank.

The work of dredging the ship channel across the river to the 22 foot depth was completed in August 1929. In all, the district excavated a channel 3,200 feet long, 240 feet wide and 25 feet deep from deep water offshore to the shoreline, hence about 3,000 feet long, 180 feet wide, and 22 feet deep across the Indian River to a turning basin, 900 by 775 feet wide at Fort Pierce, where a terminal was constructed. During the years 1926-27, as mentioned previously, the District reconstructed the parallel jetties 900 feet apart and 1800 and 1200 feet long on the north and south sides of the inlet respectively to protect the entrance channel. Banks through the inlet were revetted with Florida coquina limestone also. With the material excavated from the channel across the Indian River, a 3,950 foot long causeway was built, generally paralleling the channel about 900 feet to the south of the channel. The causeway was built with openings at each end and spanned by trestle bridges. The causeway as it was originally built can be seen in an aerial photo of Fort Pierce Inlet taken in 1936 (Figure 2).

The harbor was opened to general commerce on February 22, 1930, at a reported cost of $2,500,000 by local interests.

Shortly after opening of the harbor, maintenance problems were encountered. In March 1930, the minimum depth in the inner channel was reduced to

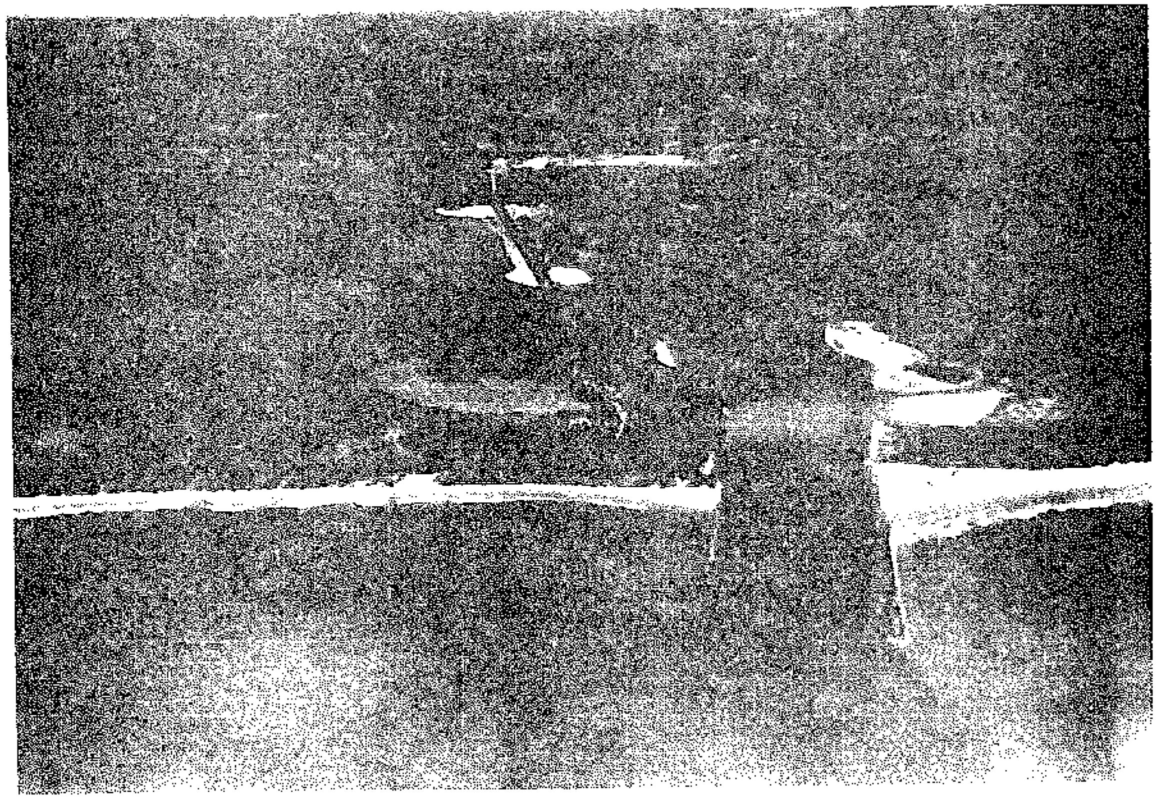

FIGURE 2 OBLIQUE AERIAL PHOTO OF FORT PIERCE INLET 3-18-36

16 feet. Between March 23 and July 8, 1930, this shoal was partially removed by the Fort Pierce Inlet Commission with a 10" hydraulic dredge. The captain of the dredge estimated that about 40,000 cubic yards of material were removed at that time, and a depth 18-22 feet was left over the shoal. The channel quickly shoaled again until a survey in February 1931 reported a minimum depth of 12 feet with an average depth of 14 feet across the entire channel. During this period the first Federal appropriation for dredging of the Fort Pierce channel was made in the Deficiency Act of March 4, 1931. The act provided $20,000 for the dredging of the channel subject to the condition that local interests agree to maintain the channel after the dredging thereby provided for was completed.

After such guarantee by the Board of Commissioners of the Fort Pierce Port Authority (former Fort Pierce Inlet District) to the U.S. Government, the channel was restored to original dimensions in April 1931, and in places overdredged to 23-26 feet. By November 1931 the channel had again shoaled to a controlling depth of 12.7 feet.

During the first two years of the inlet's existence, the greatest shoaling problem occurred in the channel bend just inside the inlet (see Figure 3, from House Document (HD) No. 252, 72nd Congress, 1st Session). This was believed due to the scouring of material from the constricted channel between the east end of the causeway and the barrier island with the consequent deposit of the material in the channel. Local residents, familiar with conditions at that time stated that little noticable change had occured in the river bottom elsewhere. Just after completion of the causeway, depths in the constricted east causeway channel were 3½ to 4 feet, while in a 1931 survey, depths in the same locations were reported to be approximately 12 feet. Also, in the same area, the bottom was stripped of the overburden of sand and shell to the more

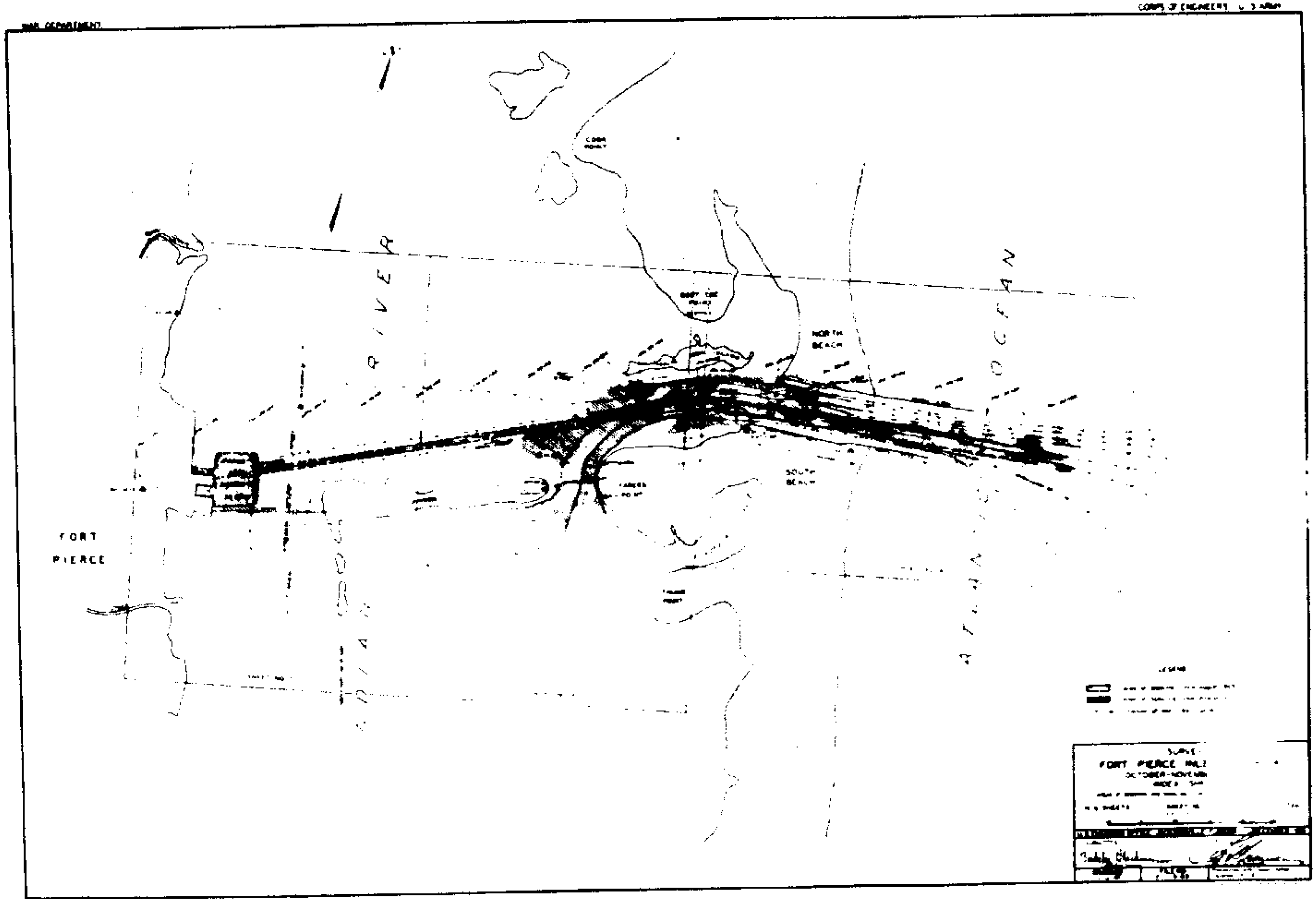

FIGURE 3 FORT PIERCE INLET, FLORIDA, FROM H.D. NO. 252, 72nd CONGRESS, 1st SESSION : SURVEY OF 1931

stable and resistant stratum of stiff blue clay or marl.

A secondary shoaling area had formed off of the south jetty and was enroaching upon the channel at this time. Various theories as to the source of this shoaling were proposed although the shoaling was most likely due to the seasonal movement of northward littoral drift in reasonably shallow depths off of the end of the south jetty.

Table 1 is reproduced from HD 252, 72nd Congress, 1st Session, and shows material scoured from the lagoon to be equal in quantity to material shoaled in the channel and lagoon in the inlet bay area. In the reference cited, it is suggested that such a balance might be somewhat misleading though, in that shoaling material in the turning basin consisted mostly of alluvial silt from the surrounding creeks while shoaling at the inlet entrance was probably due to littoral drift movement. On reanalysis, no good estimate was made of the quantity of sand in the inlet derived from ocean sources, although this early work by the Corps seems to suggest that the volume of such sand was very little as would be expected due to the influence of the jetties. The 200,000 cubic yards of sand tied up in the offshore bar in the 2 years after the completion of the project suggests an annual figure of 100,000 cubic yards, but little confidence can be placed in such a figure.

Shoaling and scouring problem areas and tidal ebb current patterns as they existed at the time of the 1931 survey are shown in Figure 3, as mentioned previously.

This same survey also mentioned that the jetties had experienced local subsidence to a level approximately 2 feet above MLW and some disintegration of the coquina rock. The shore end of the north jetty for approximately 400 feet had moved south an average of 25 feet while the seaward end of the South jetty had moved south also. A number of gaps existed in the jetties caused

Table 1

(From House Document 252, 72nd Congress, 1st Session)

The quantities of material removed from the various principal areas of scour since completion of the harbor have been at least as great as the following:

	Cubic yards
From area around turning basin and through west bridge[a]	125,000
From bottom of ship channel across Indian River	25,000
From area south of ship channel through east bridge	240,000
From area between ship channel and Coon Island	50,000
From bottom of ship channel through inlet between jetties	135,000
Total	575,000

The total material deposited in the shoals has been estimated roughly as follows:

	Cubic yards
In turning basin and west section of ship channel	125,000
In shoal opposite east end of causeway island	35,000
In bend of ship channel (previously removed)	130,000
In bend of ship channel (now in place)	25,000
In shoals in river south of east bridge	60,000
In shoals beyond ends of jetties	200,000
Total	575,000

[a] A considerable proportion of this material seems to be a fine silt mud probably brought down into the Indian River by the near-by creeks.

(Note: These quantities represent shoaled and scoured material in the vicinity of Fort Pierce Inlet from the time of completion of the project until the October-November survey of 1931 (see Figure 3 for areas shoaled and scoured).)

by wave action.

A War Department Appropriation Act of 4 March 1933 provided further Federal funds for dredging in the amount of $30,000 to alleviate shoaling problems in the inlet.

During the early thirties, Fort Pierce was working toward a transfer of responsibility for channel maintenance works and channel dredging from local government to federal government. In pursuing this matter, local authorities stressed the advantages of Fort Pierce's existing harbor over other considered harbor projects. In Reference 4, an overview of the situation is presented, part of which is as follows:

> "The question of the most feasible center for this anticipated water-borne commerce has been the subject of considerable rivalry among the residents of various communities on the east coast; Fort Pierce, Stuart, West Palm Beach, and Port Everglades have all been the scene of much local agitation and expenditure in connection with harbor improvements, the justification for which has been predicated in large measure on the suitability of the site as a terminal and junction point for the anticipated water-borne traffic from the Lake Okeechobee region.
>
> In addition to the St. Lucie Canal, reaching the east coast at Stuart, four other State drainage canals connect Lake Okeechobee with the waterways of the east coast. These are the West Palm Beach Canal at West Palm Beach, the Hillsborough Canal at Deerfield, the North New River Canal at Fort Lauderdale and Port Everglades, and the Miami Canal at Miami. None of these canals are now navigable throughout except by small boats, and even by them only with difficulty; there is no present indication that any of these canals are likely to be developed in the near future to such degree that the status of the St. Lucie Canal as the only practicable artery of water-borne commerce between the east coast waterways and the Lake Okeechobee region will be altered.
>
> Under existing conditions, therefore, two active ports are apparently most available for the handling by water of the commerce passing over the St. Lucie Canal - Fort Pierce and West Palm Beach. Of these, Fort Pierce seems to be most advantageous, for the following reasons: First, it is distant only about 20 miles by the Intracoastal Waterway from the eastern terminus of the St. Lucie Canal and River, whereas the Port of West Palm

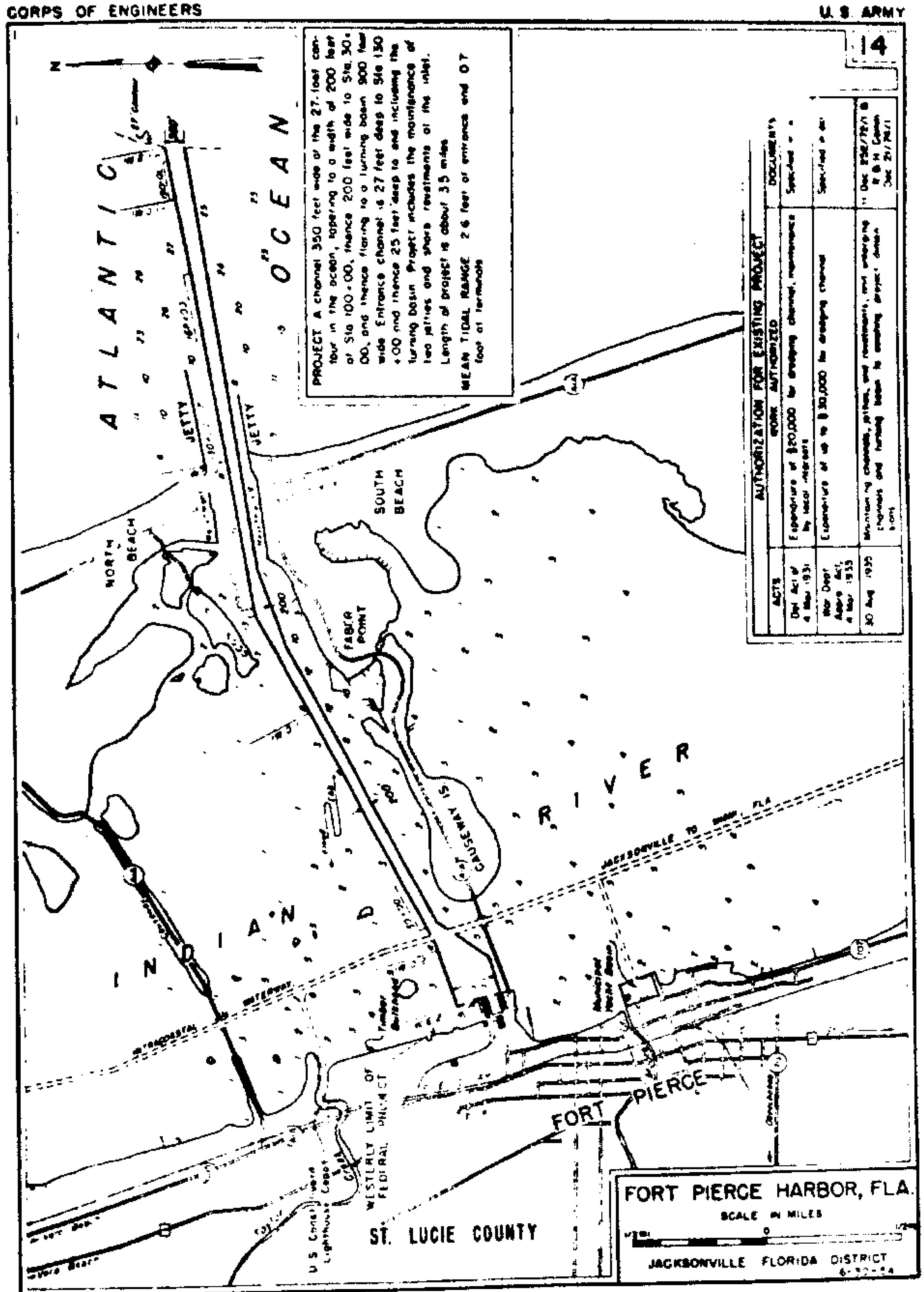

FIGURE 4 FORT PIERCE HARBOR, FLORIDA – JACKSONVILLE DISTRICT, U.S. ARMY CORPS OF ENGINEERS NAVIGATION PROJECT DRAWING

> Beach is over 30 miles distant from the same point; second, the waterway between St. Lucie Inlet and Fort Pierce Harbor is straight and wide, permitting of full speed by boats or barges, whereas much of the waterway between St. Lucie Inlet and the Port of West Palm Beach is narrow and tortuous; third, the proposed limiting depth in Fort Pierce Harbor is 22 feet, whereas that in the Port of West Palm Beach is but 16 feet; fourth, (the contemplated erection of the precooling plant at) Fort Pierce, with probable installation of refrigerated compartments on vessels calling there will afford facilities for the shipment of fruit and vegetables not now contemplated, so far as is known, at the Port of West Palm Beach."

These views were supported by further legislation. In the Rivers and Harbors Act of 30 August 1935, federal responsibility was assumed for maintaining channels, jetties, and revetments, and enlarging channels and turning basin to present project dimensions. Projects dimensions for the federal project at Fort Pierce Harbor (and Inlet) are shown in Figure 4, taken from the Jacksonville District, U.S. Army Corps of Engineers, Navigation Project Drawings. The adopted project was completed by the United States in 1938.

A complete listing of maintenance dredging work through 1960 at Fort Pierce Inlet is given in Table 2.

It is interesting to note that a sabellariid worm reef is presently encroaching on the inlet's main channel from the north side of the channel about midway through the inlet. The reef is growing perpendicular to the flow and is significantly altering the flow patterns in the inlet. Sabellariid worm reefs are noted to grow in the tropical coastal zone of Florida where there is an abundant supply of sand and water turbulence (i.e. surf zone) to bring the sand to the worms. This suggests that a great deal of sand is presently entering the inlet and the channel through or around the north jetty. Further encroachment of the channel by the worm reef may significantly alter the flushing aspects of the inlet and hinder navigation through the inlet.

Table 2

Maintenance Dredging in Fort Pierce Inlet and Harbor

1930 through 1972

Year	Volume[a] (cu.yd.)		Location	Method	Disposition
1930	40,000		Channel	Pipeline	?
1931	103,516		Channel and bar	Hopper dredge	At sea
1933	198,734		"	"	"
1934	123,888		Channel and turning basin	Pipeline	Indian River
1935	113,177		Channel	"	"
1936	141,170		"	Hopper dredge	At sea
1937	1,246,355		Channel and turning basin	"	"
1938	124,066		"	"	"
1939	176,987		Channel	"	"
1940	239,425		Channel and turning basin	"	"
1941	58,686		Channel	"	"
1942	69,079		Channel and turning basin	"	"
1944	63,133		Channel	Pipeline	Indian River
1945	10,900		"	"	"
1947	235,060		Channel and turning basin	Hopper dredge	At sea
Sept. 1949	164,423	(73,990)[b]	"	"	"
Dec. 1951	64,800		Channel	"	"
1952	63,412		"	"	"
Mar. 1954	153,190	(65,211)	Channel and turning basin	"	"
Nov.55/Dec.1956	78,761	(33,529)	"	"	"
Feb. 1957	104,281	(54,338)	"	"	"
Jan. 1958	13,165		Channel	"	"
1959	26,634		Channel and turning basin	"	"
1966	185,000		"	Pipeline	Indian River (upland area)

[a] Volume figures for hopper dredges are bin figures and should be divided by a 1.2 bulking factor for a more representative estimate of solid material dredged.

[b] Quantities in parenthesis are volumes of material dredged from the channel only; i.e., in 1949 73,990 cu. yds. were dredged from the channel, and 164,423 - 73,990 = 90,433 cu. yds. were dredged from the turning basin.

HISTORY OF SHORELINE CHANGES

Unfortunately, no reliable data are available concerning erosion at Fort Pierce prior to the cutting of the inlet in 1920. The shoreline probably receded slowly and irregularly along the continuous barrier island.

The overall littoral trend in the area since creation of Fort Pierce Inlet has been one of erosion, although, due to the inlet's influence, is one of accretion north of the inlet, and erosion south of the inlet.

The Fort Pierce area is unique in that erosion exists on the North side of the inlet where loss of sand due to many reasons outweighs accretion due to the north jetty of the inlet. Reasons for a dominant erosional trend on the inlet's north side are probably many, although four major factors are: (1) Leakage of sand through the north jetty during periods of southward drift (dominant direction of drift); (2) A longer north jetty than outh jetty; therefore cutting off much of the northward drift during periods of northward drift; (3) A gradual filling in of the old Indian River Inlet and consequent building of dunes in that area, and (4) the eustatic rise in sea level (see Reference 6).

The shoreline for about a mile north of the inlet has generally advanced although outer portions of the profile have eroded making the beach on the north side of the inlet generally steeper than would be expected, especially considering the amount of fine sand found in the profiles. The volumetric erosion rate of sand over the entire profile averaged over 1 mile section directly north of the inlet is 8,000 cubic yards per year, as given in Reference 1. During the period of record 1930-1957, the 1 mile section of shore directly north of the inlet advanced its high water shoreline an average of 5.2 feet annually while eroding its outer sections of the profile to base rock.

Erosion has been a continuing problem on the south side of the inlet. An estimated volumetric rate of erosion of 93,000 cubic yards per year for the 2.7 mile sector directly south of the inlet has been given in Reference 1 for the 1930-1957 period. Unlike the north side of the inlet, the erosion occurs over the entire profile on the south side of the inlet. For the same period, the average annual shoreline recession has ranged from 3 - 6 feet south of the inlet. The most severe erosion has occurred approximately 1,200 feet south of the inlet where the shoreline has receded as much as 450 feet during the 1930-1957 period.

Figure 5 is a composite aerial photo showing the general shoreline trends in the vicinity of Fort Pierce Inlet. A more complete view of shoreline changes in the area is shown in Figure 6 condensed from information presented in Reference 1.

The loss of beach front land and the encroachment of the ocean on private property spurred Fort Pierce to action. The Fort Pierce Beach Erosion District was organized in 1949 under a special act of the Florida legislature on Hutchinson Island between Fort Pierce Inlet and the Martin County line.

In 1957, the Coastal Engineering Laboratory of the University of Florida was engaged as a consultant to recommend solutions for alleviating the erosion problem on the south side of Fort Pierce Inlet. In their report (Reference 7) a detailed description of shoreline conditions at that time is given. Figure 7 shows conditions of the beach directly south of the inlet in 1960. This study recommended: (1) beach nourishment on the south side of the inlet, (2) a sand trasfer plant for natural bypassing at the inlet, (3) making jetties impermeable to stop leakage of sand into the inlet, (4) creating a dune (dike)

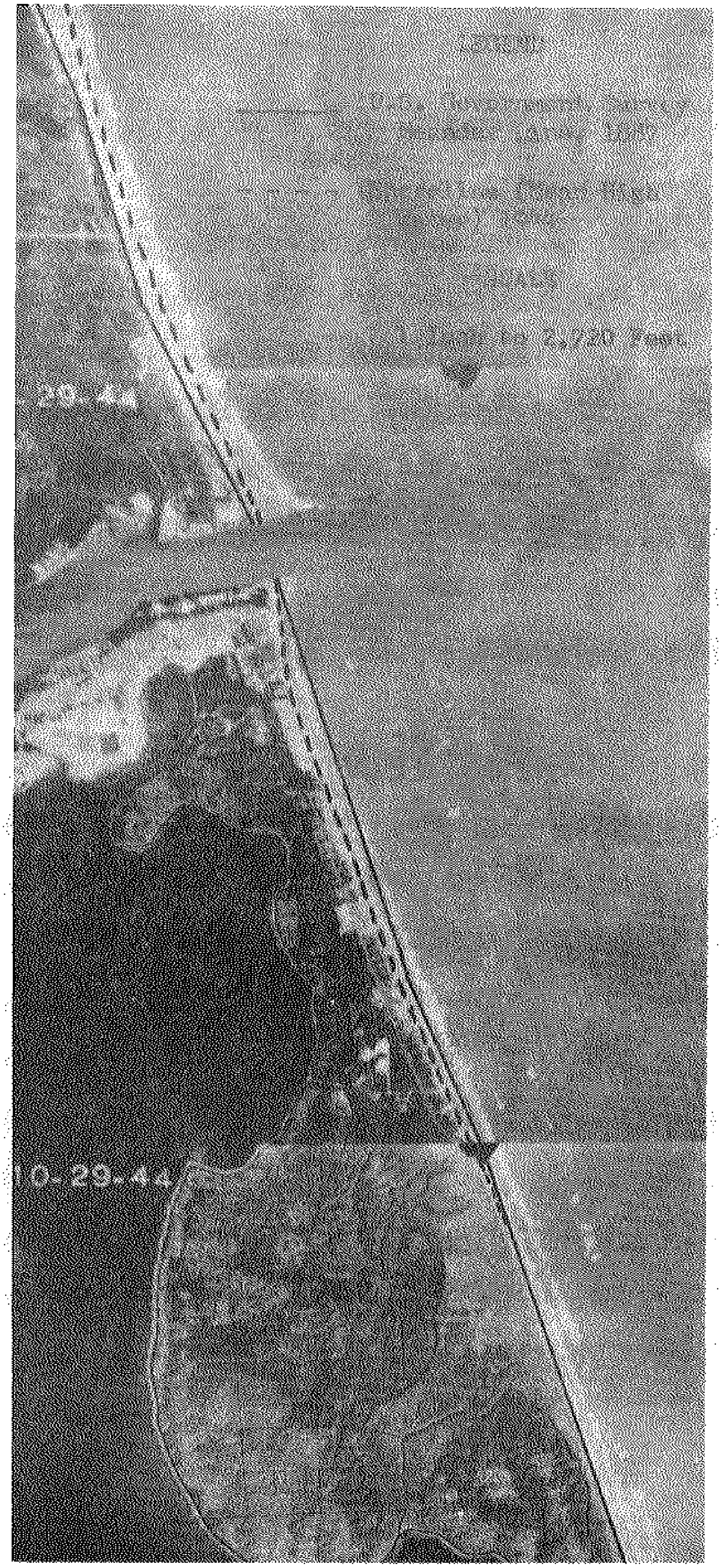

FIGURE 5 COMPOSITE AERIAL PHOTOGRAPH SHOWING SHORELINE CHANGES AT FORT PIERCE INLET

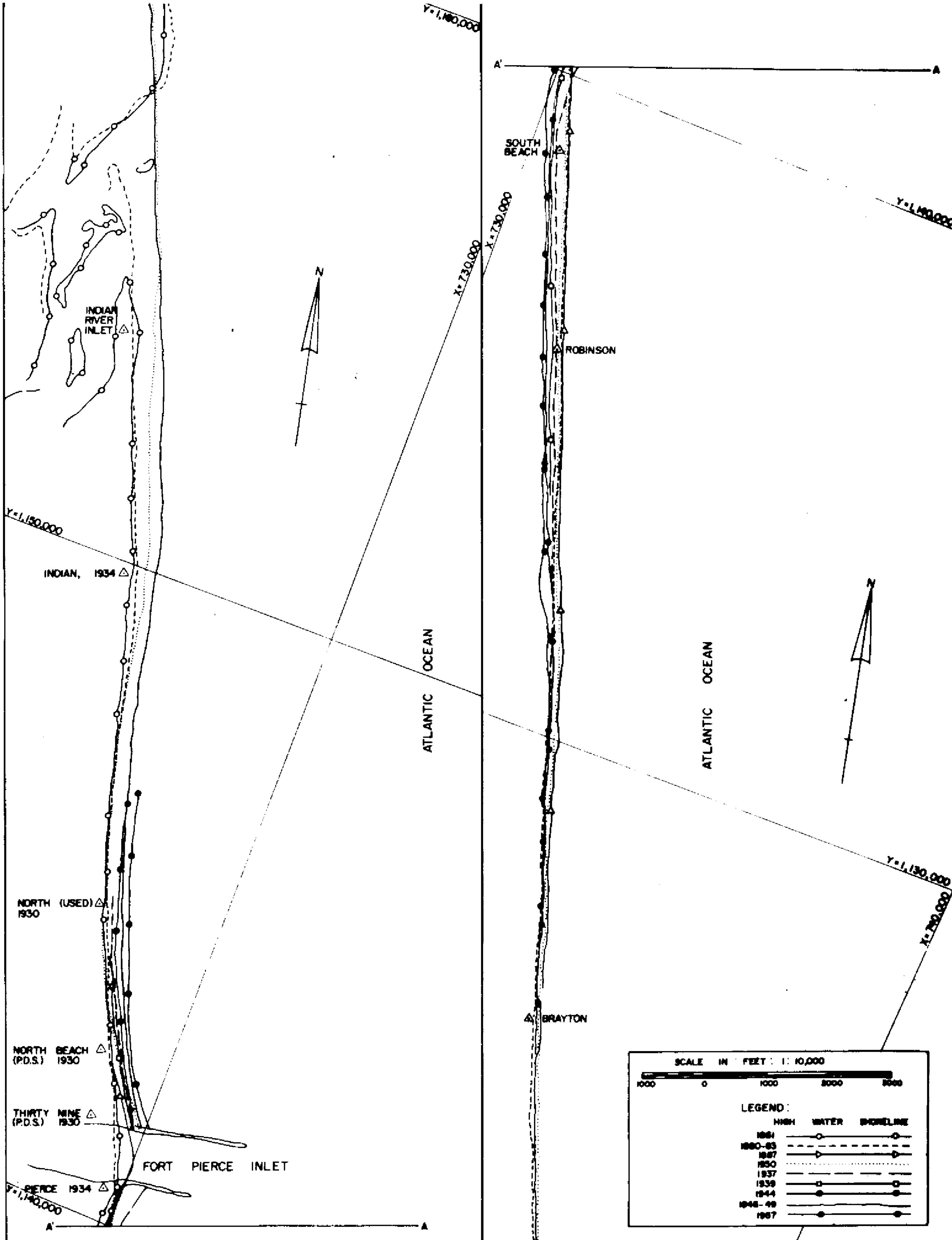

FIGURE 6 SHORELINE CHANGES AT FORT PIERCE, FLORIDA, (FROM REFERENCE 1)

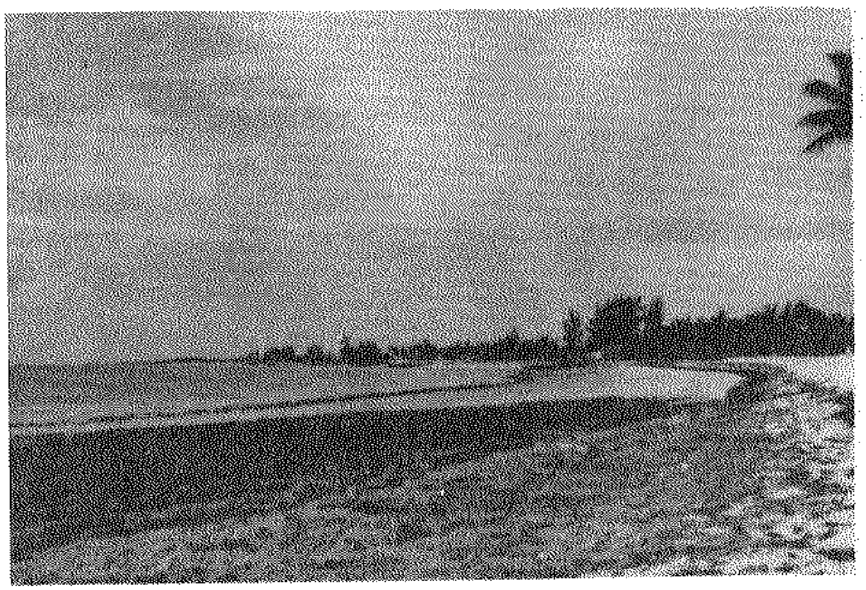

FIGURE 7 CONDITIONS OF BEACH SOUTH OF FORT PIERCE INLET 1960

along the shoreline to prevent further flooding in areas where natural dunes were lost and (5) temporary protection of buildings endangered by erosion.

Due to a lack of federal funds for the project, no corrective action was taken at that time.

Damage from northeasters and hurricanes had been moderate in the area until 1962. A severe northeaster in March 1962 caused considerable erosion of the beach south of Fort Pierce Inlet, as high breakers rolled over the section of the beach which lacked a dune line (long before having eroded away). Parts of the beaches were reported to have been lowered by as much as 10 feet. The ocean-front road, elevation 6 feet, had one-half foot of water over it during the height of the storm, and water entered homes along the road. The foundations of a few homes were undermined, and many homes had to be abandoned.

As beach conditions worsened, minor amounts of beach fill were truck-loaded and dumped on the beach at the Lions Club Beach Park approximately 1.2 - 1.3 miles south of the south jetty.

In House Document No. 84, 89th Congress, 1st Session, federal participation in a beach restoration project was recommended for the 1.3 mile stretch of beach directly south of the south jetty. The area for the nourishment and the design specifications for the beach restoration are shown in Figure 8 taken from that document. The estimated volume of material required for initial improvement was about 500,000 cubic yards, and the estimated volume of annual nourishment was 90,000 cubic yards.

In 1969, St. Lucie County signed a dredging contract with Ocean Dredging Incorporated, a private firm which was at the time experimenting with a submersible dredge, a totally new concept in offshore dredging. The submersible dredge commenced pumping sand onto the beach on December 12, 1969.

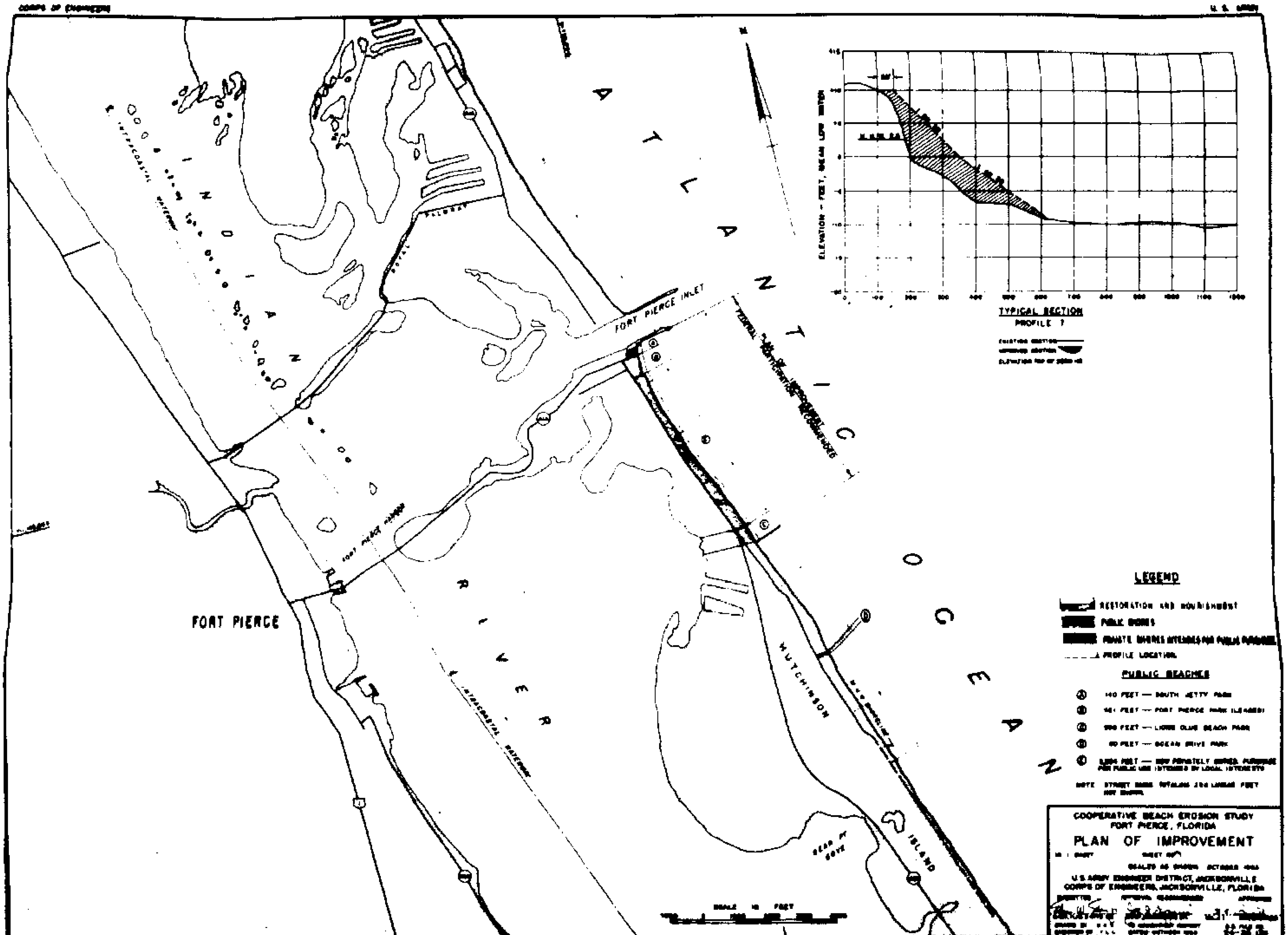

FIGURE 8 BEACH RESTORATION PROJECT AT FORT PIERCE 1970 (FROM REFERENCE 1)

Many problems were encountered with the dredge, and finally, the beach nourishment dredging had to be subcontracted out to a conventional pipeline hydraulic dredge somewhat modified to accomplish the job in an ocean wave climate. The surface dredge "Buster Bean" commenced pumping sand in June of 1971, and finished the project in July of the same year. The total volume of sand dredged amounted to 651,357 cubic yards at a cost of $579,708.00, or 89¢ per cubic yard. The borrow area for the sand was located approximately 2,000 feet offshore in 20 feet of water.

Present plans exist for replenishment of the beach every 5 years with a recommended volume of sand equal to 450,000 to 500,000 cubic yards. Presently the Corps of Engineers is investigating a project for the mitigation of shore damage as authorized in Section 111 of the River and Harbors Flood Control Act of 1968. This act makes it mandatory for the Federal Government to assume total financial responsibility for beach restoration projects in cases where federal projects (such as inlets) are responsible for the damage.

CLIMATOLOGY OF THE FORT PIERCE AREA

Astronomical Tides and Currents

The tide in the vicinity of Fort Pierce Inlet is semidiurnal with a large daily irregularity. The mean range of the tide in the Atlantic Ocean is 2.6 feet and the spring tide range is 3.0 feet. The range of tide in Faber Cove inside the inlet and east of the causeway varies from 0.5 - 0.9 feet. Figure 9 (Figure 5 in Reference 7) is a 3-day recording of tides and currents at Fort Pierce Inlet. The tide in Faber Cove is seen to lag the ocean tide by approximately 2 hours, while maximum flood current in the inlet corresponds approximately to high tide in the ocean. The coincident high tide and maximum flood current suggest that the inlet is very inefficient hydraulically. Part of the reason for this inefficiency can be seen in Figure 10, which shows the inlet on a flood tide. This aerial photo shows separation of flow at the tips of the jetties.

The survey of 1931 mentions a measured maximum ebb current in the inlet of approximately 4.5 feet per second, which corresponds well to the maximum ebb current shown in Figure 9, taken in the 1958 survey. Although currents in the inlet seem to be the same, undoubtedly, the tidal prism of the area has been greatly reduced by the building of the causeway to the north of the inlet, (date of construction is unknown), and the closing off of the east section of the causeway south of the inlet.

Apparently, an equilibrium inlet cross sectional area has been reached which must be smaller than it was in 1931. Discharge in turn, must also have been reduced from its maximum ebb value of 68,000 cfs measured in 1931.

The shallowness of the inlet area, the mixing caused by the ocean tide,

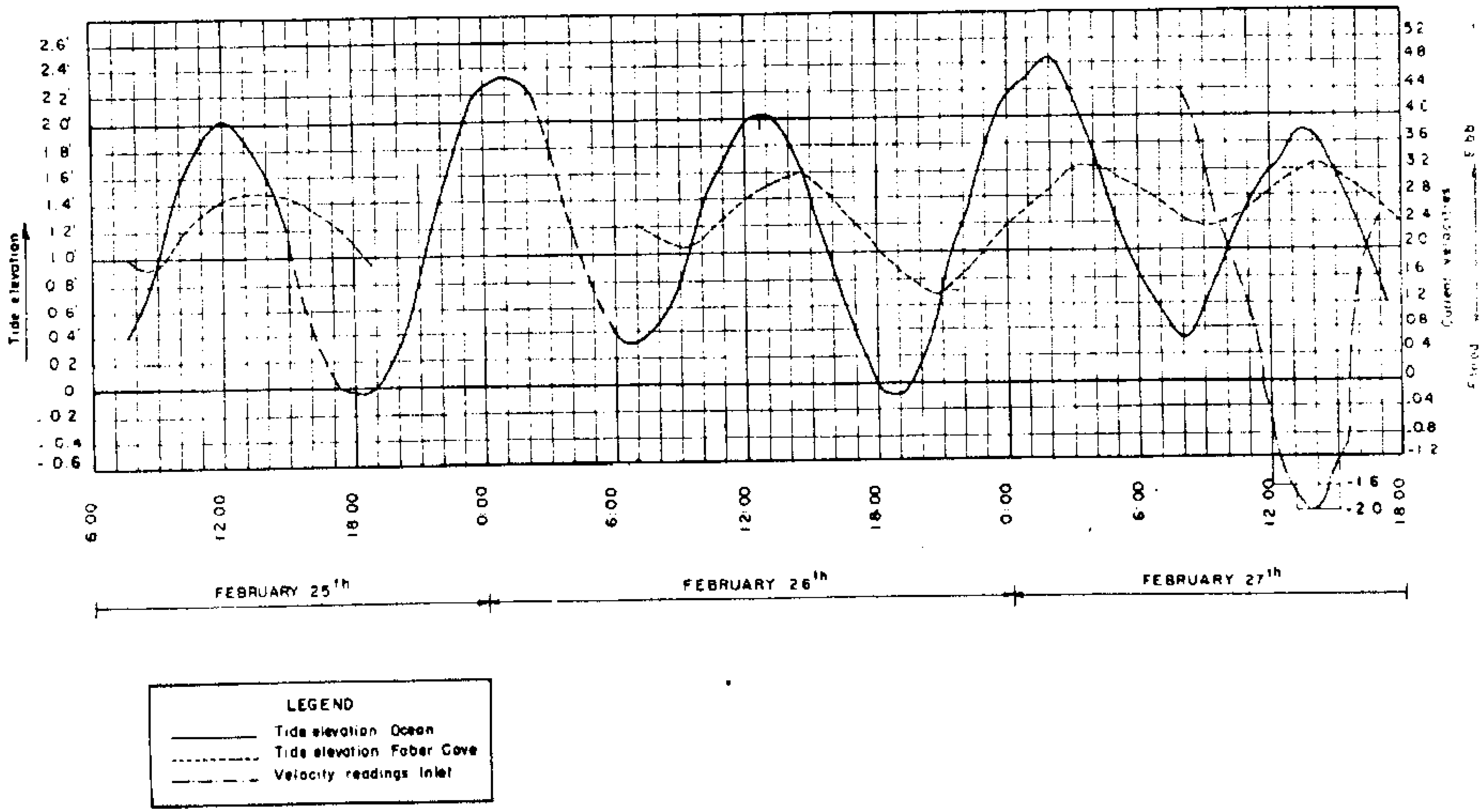

FIGURE 9 TIDE AND CURRENT OBSERVATIONS AT FORT PIERCE INLET; 1958
(FROM REFERENCE 7)

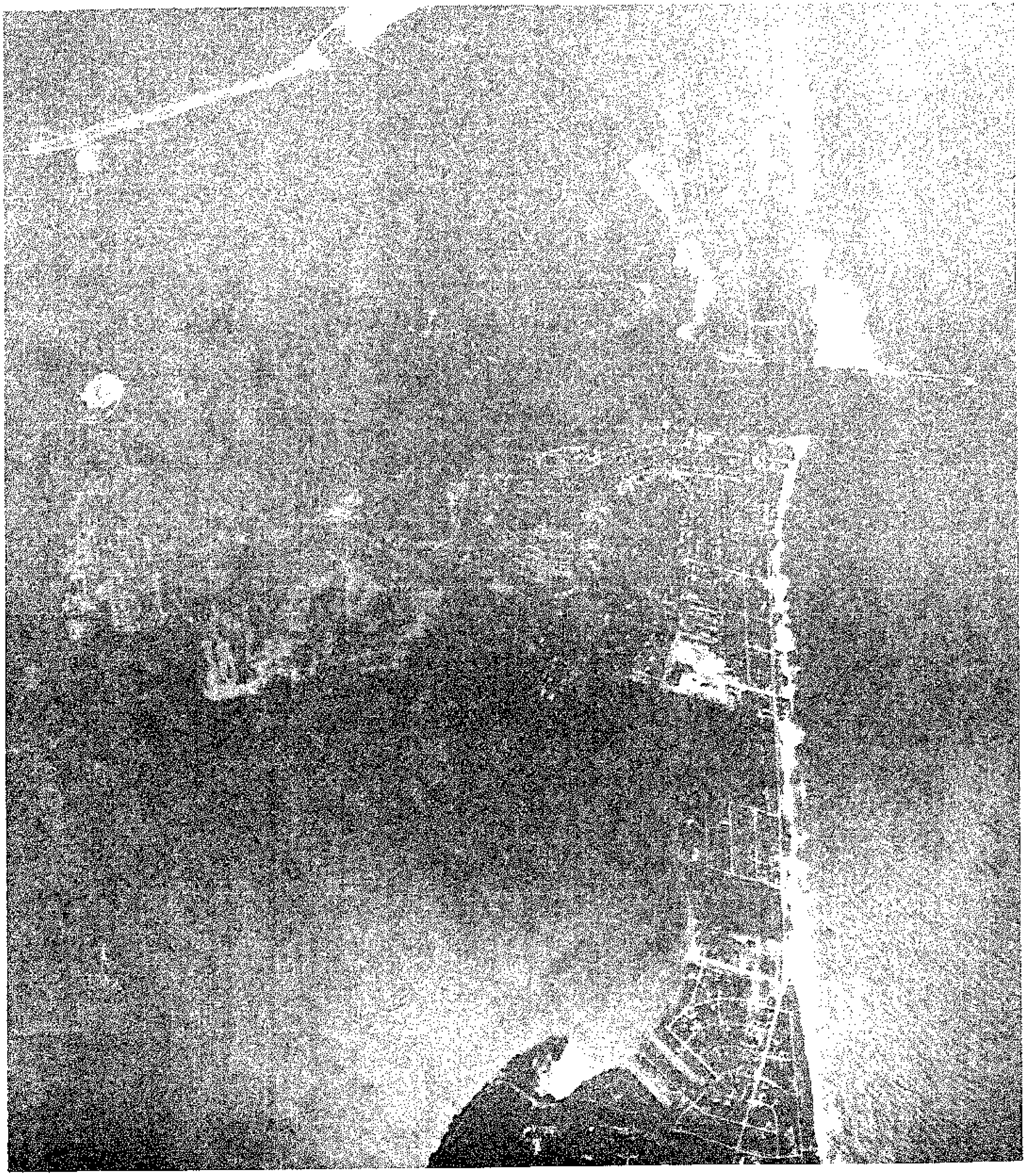

FIGURE 10 NATIONAL OCEAN SURVEY AERIAL PHOTOGRAPH OF FORT PIERCE INLET 2-10-70

and the lack of an appreciable fresh water inflow into the inlet's area of influence are factors that result in a mixed water column. The Fort Pierce inlet area water is appreciably mixed over the depth except at slack waters where a slight difference in salinity is noticed from top to bottom.

Storm Tides

Deviations from the normal tide level in the ocean occur due to wind stress on the water surface, wave set up, and deviations from normal barametric pressures. The extreme water level fluctuations occur with hurricanes and major extratropical storms.

Information on extreme tides in this area is sparse, but during the October 1953 hurricane, an ocean tide level of 6.3 feet was recorded by the U. S. Geological Survey at Eau Gallie to the north of Fort Pierce. Known high tides measured in the Indian River (ocean tide unknown at corresponding times) have occurred during the hurricane of September 6-20, 1928, 7 foot tide at Melbourne; and the northeaster of March 1962, 6½ foot tide at Fort Pierce.

The University of Florida and the National Oceanic and Atmospheric Administration have both derived storm tide level vs. frequency of occurrence curves for this area (Reference 8). These curves are presented in Figure 11 (Figure 12 in Reference 8). The NOAA curve shows a 7 foot tide to be a 1 in 50 year occurrence while the University of Florida curve predicts the same storm tide level for a 1 in 25 year occurrence, approximately. The true frequency of occurrence is probably somewhere between these curves.

During the period 1900 - 1962, a total of 17 hurricanes passed within a 50 mile radius of Fort Pierce. This is a hurricane frequency of 1 in 3.7 years. If the number of severe northeaster storms were added to the list,

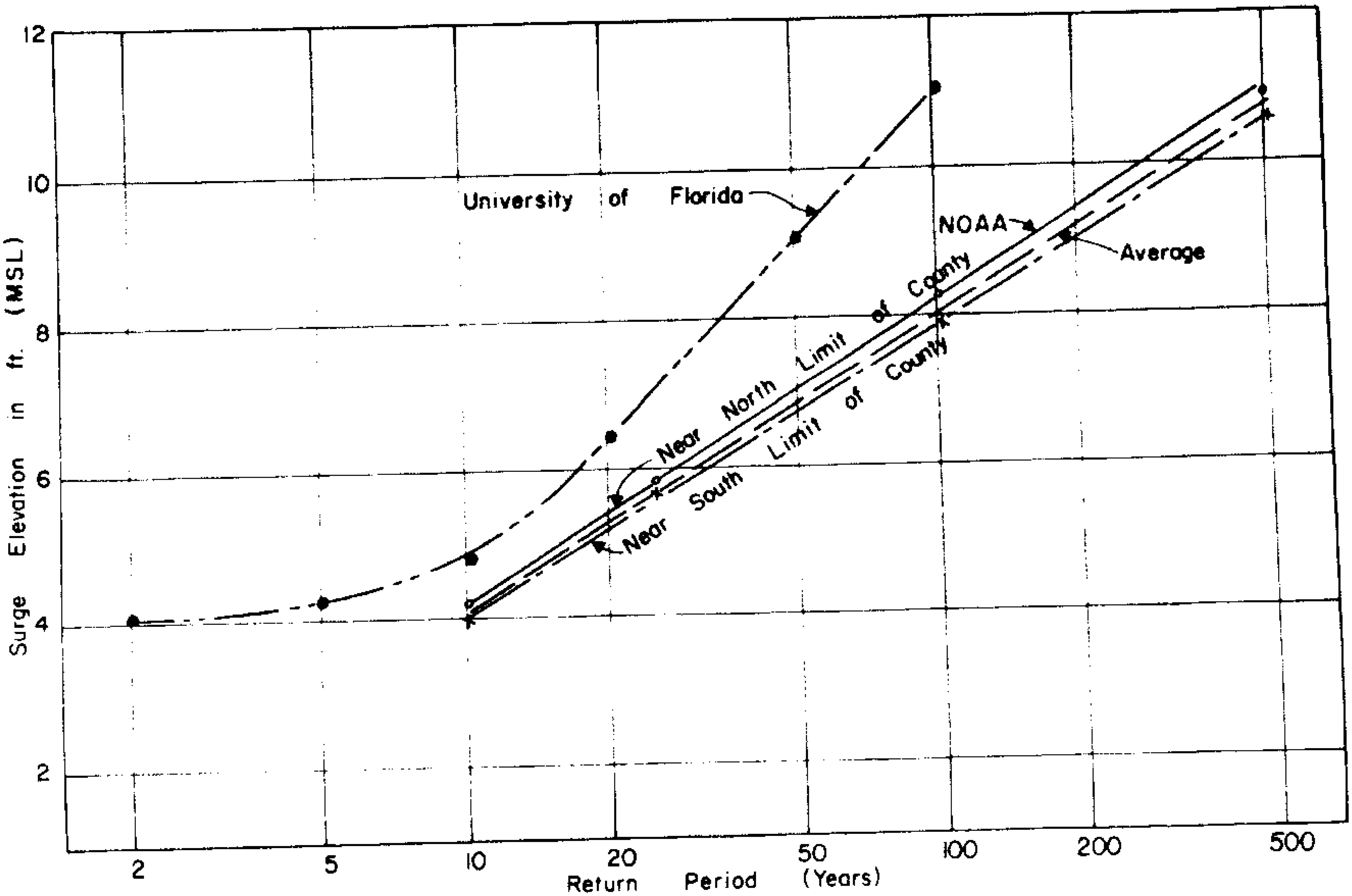

FIGURE 11 STORM SURGE FREQUENCIES FOR ST. LUCIE COUNTY, FLORIDA (FROM REFERENCE 8)

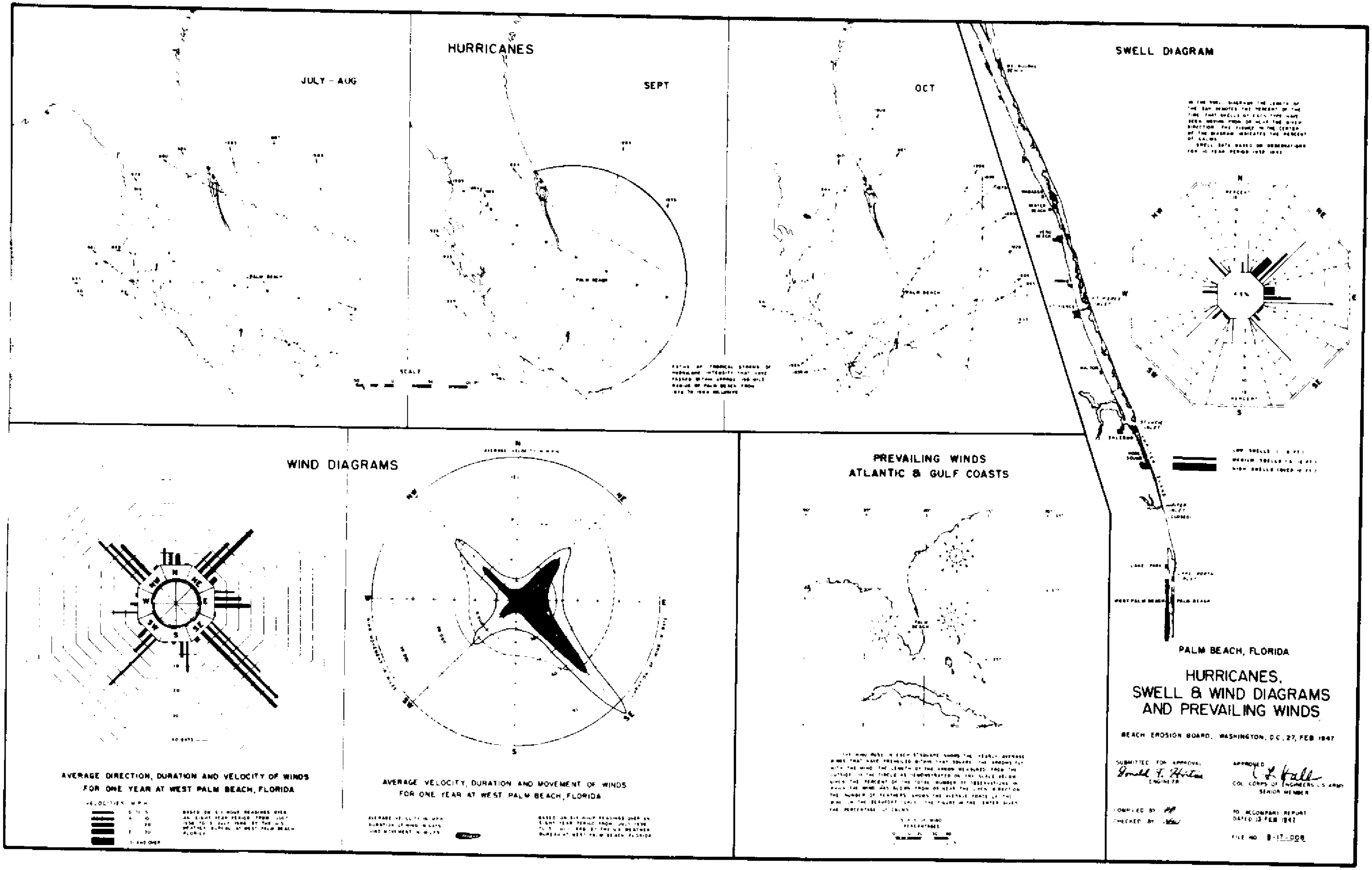

FIGURE 12 HURRICANES, SWELL AND WIND DIAGRAMS, AND PREVAILING WINDS AT PALM BEACH, FLORIDA (FROM REFERENCE 1)

the storm frequency would be considerably higher. Unfortunately the effect of the hurricanes and extratropical storms on the Fort Pierce Inlet and surrounding shoreline has not been well documented. It is believed that the hurricanes have a tendency to drive a great deal of sediment into the inlet where it is trapped in shoals, in addition to causing tremendous erosion problems due to strong longshore currents and steep waves. In the case of Fort Pierce Inlet, the jetties tend to restrict the flow of sand into the channel and inner recesses of the lagoon and consequently transfer the problem of sand loss to the downdrift side of the inlet. The worst storm with regard to erosion of Fort Pierce beaches was the northeaster of March 1962 mentioned previously.

The presence of the inlet creates an additional problem by providing an easy access route for flood waters and waves to reach the lagoon and Fort Pierce. This problem was evident in the storm of September 11 - 19, 1947 when tides and wave action entering the inlet overtopped seawalls normally 8 to 10 feet above the level of the Indian River, flooding streets along the waterfront, and, again, in the storm of August 24 - 29, 1949, when many homes along the west shore of the Indian River were flooded.

Winds

Onshore wind records of the United States Weather Bureau for the period 1938-1946 at West Palm Beach have been compiled and recorded in House Document 772, 80th Congress, 2nd Session. Figure 12 is reproduced from this document. The West Palm Beach wind rose shows that wind velocities were greater from the northeast sector than from the southeast sector, but that duration of wind and wind movement were greater from the southeast sector. It is felt that these onshore winds are also representative for the St. Lucie area.

Yearly cumulative average offshore wind data compiled from ship observations in the 5 degree offshore square shown in Figure 12 are summarized in Table 3. It should be noted that these data are of more importance than local wind data since winds from offshore areas are primarily responsible for waves acting on the coastline. The Figure 12 wind rose and Table 3 indicate that the strongest winds are from the northern sector and the predominant winds in the general area are from the northern and eastern sectors, but that on the average, the percentage of time that winds blow from the northeast and southeast are approximately equal.

Table 3

Yearly Cumulative Average Offshore Wind Data

(from observations 1879 to 1933)

Direction	Percent of time	Direction	Percent of time
North	10	Southwest	6
Northeast	16	West	5
East	22	Northwest	8
Southeast	20	Calms	3
South	10		

Waves

Figure 12 also shows an ocean swell rose, for the same 5° square of ocean area. A total of 40,601 observations were made during the 1932-1942 period, more or less equally distributed over each month of the year. The swells are classified according to the height of waves and are indicated on the diagram by the width of lines weighted in proportion to the square of the swell heights. The swell rose indicates a predominance of swell from the Northeast. Reference 1 states that during the months September through February, the prevailing and predominant swells are from the south and southeast, and during March, April, and May the resultant direction of swell are uncertain. Walton, in Reference 9, found similar results for Hutchinson Island using both sea and swell observations.

Littoral Drift

Littoral drift is strongly dependent on wave height and wave direction. When waves are from the north or northeast, littoral drift is southward, while for waves from the south and southeast, the direction is reversed. From the wave data presented previously, it is apparent that net littoral drift in the St. Lucie area is southward. References 1 and 10 quote a net value of littoral drift in the study area ranging between 200,000 and 250,000 cubic yards per year estimated from dredging records and volumetric surveys of accretion and erosion north of the north jetty, and predominant erosion on the south shore of the inlet. No total north or south drift values are given in either of the references.

Walton, by using ship wave observation, (Reference 9), has estimated total littoral drift as 334,000 cubic yards per year south and 281,000 cubic yards per year north; thus, a net drift of 53,000 cubic yards to the south. Also, in the same reference, a seasonal littoral drift versus month of year diagram is presented for Hutchinson Island and has been included as Figure 13. This diagram shows the predominance of outhward littoral drift from September through March, and northward littoral drift predominance from April through August.

Shoaling and bypassing patterns in the vicinity of the inlet have been estimated in Reference 7. This Reference concluded that: (1) of the 200-250 thousand cubic yards of net annual drift in the area, at least 90 per cent (160-200 thousand cubic yards annually) migrates within the 18 foot

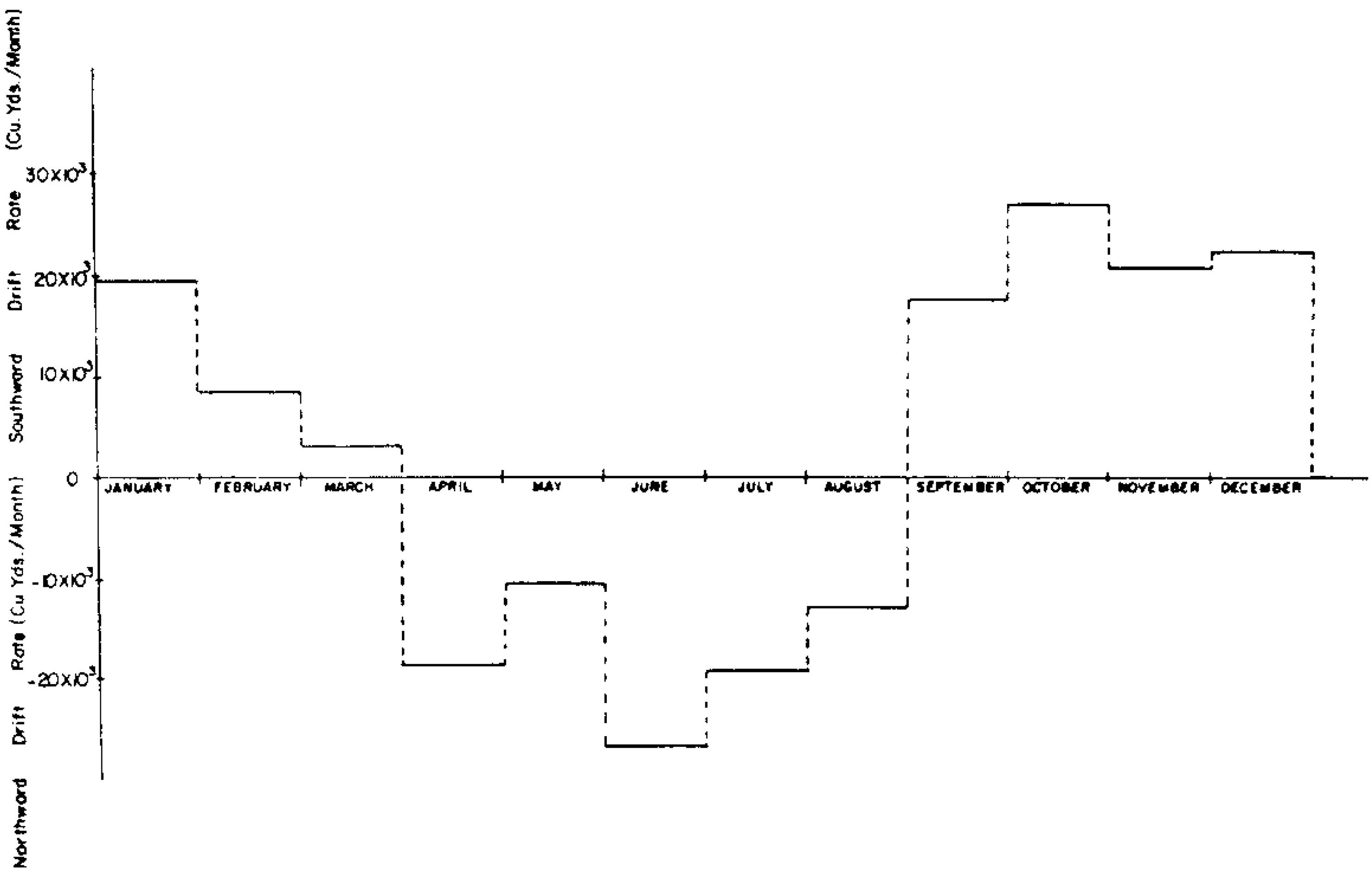

FIGURE 13 VARIATION OF NET LITTORAL DRIFT WITH SEASONAL WAVE CLIMATE BETWEEN FORT PIERCE INLET AND ST. LUCIE INLET (FROM REFERENCE 9)

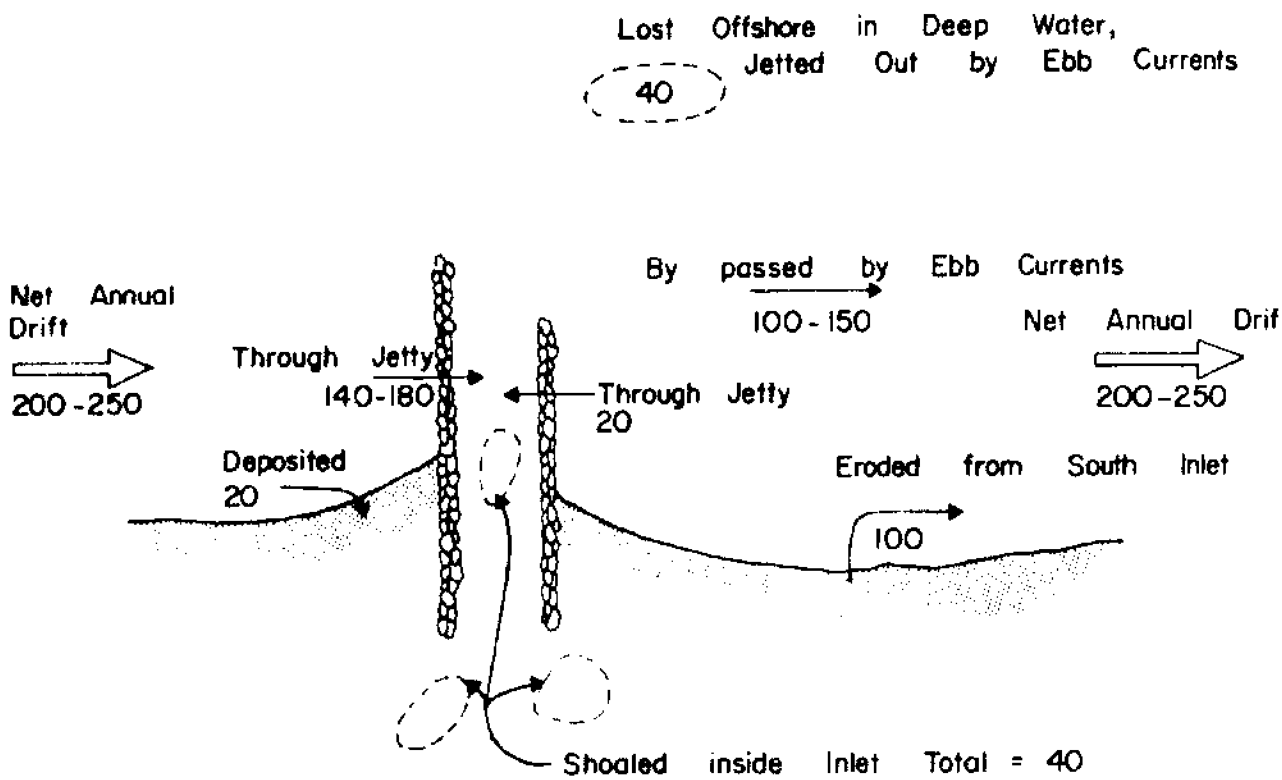

FIGURE 14 SCHEMATIC OF SAND BUDGET AT FORT PIERCE INLET (FROM REFERENCE 8); QUANTITIES ARE IN THOUSANDS OF CUBIC YARDS ANNUALLY

depth contour which is located at the extreme end of the north jetty; (2) 20 thousand cubic yards per year accumulate north of the north jetty, and 140-180 thousand pass through the north jetty reaching the inlet; (3) 40 thousand cubic yards annually are shoaled in the bay, and 40 thousand cubic yards annually are swept offshore to deep water by ebb currents; (4) leakage through the south jetty to the inlet amounts to 20 thousand cubic yards annually; (5) natural bypassing, bar and tidal, amounts to 100 to 150 thousand cubic yards per year; and (6) 100 thousand cubic yards of sand is eroded from the area south of the south jetty. A schematic of this sand budget is shown in Figure 14. Note that the major difference in littoral material quantities estimated in this study as opposed to Reference 1 is the volumetric accretion/erosion rate north of the north jetty. Reference 1 stated a net erosion of 8,000 cubic yards annually in this section as opposed to Reference 7 which states a net accretion in the section.

Reference 7 also states:

> "The peculiar shape of the offshore bottom profile with an almost horizontal platform at 10 to 12 foot depth is probably responsible for the fact that the inlet, to a considerable extent, works as a natural sand transfer plant."

This perhaps explains in part why Fort Pierce has not had as great an erosion problem as have many inlets to the south of Fort Pierce.

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APPENDIX

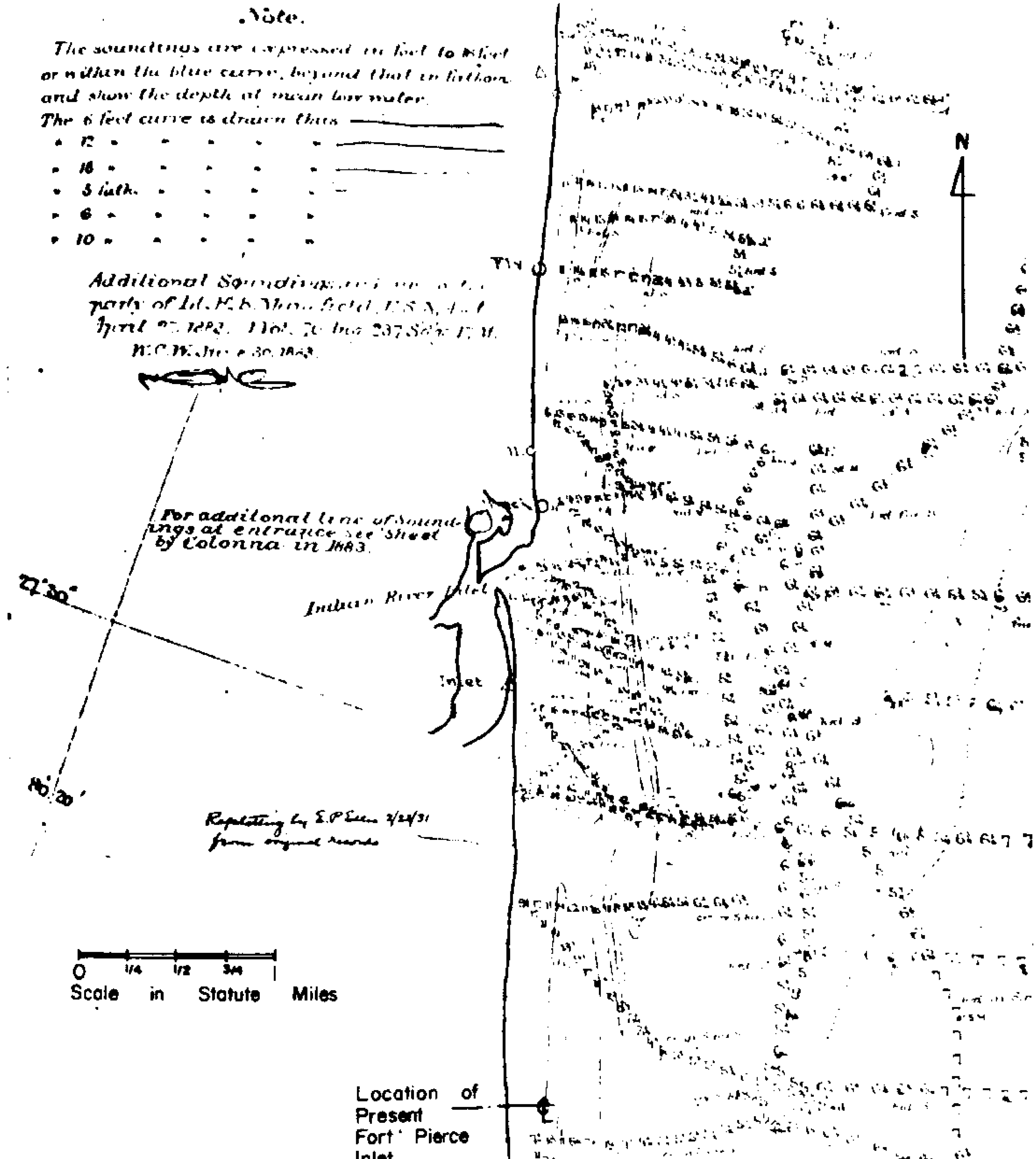


FIGURE A1
LOCATION OF OLD INLET AND PRESENT INLET. PORTION OF NATIONAL OCEAN SURVEY (U.S.C.& G.S.) CHART H-1523a
SCALE 1: 40,000 SURVEYED 1882

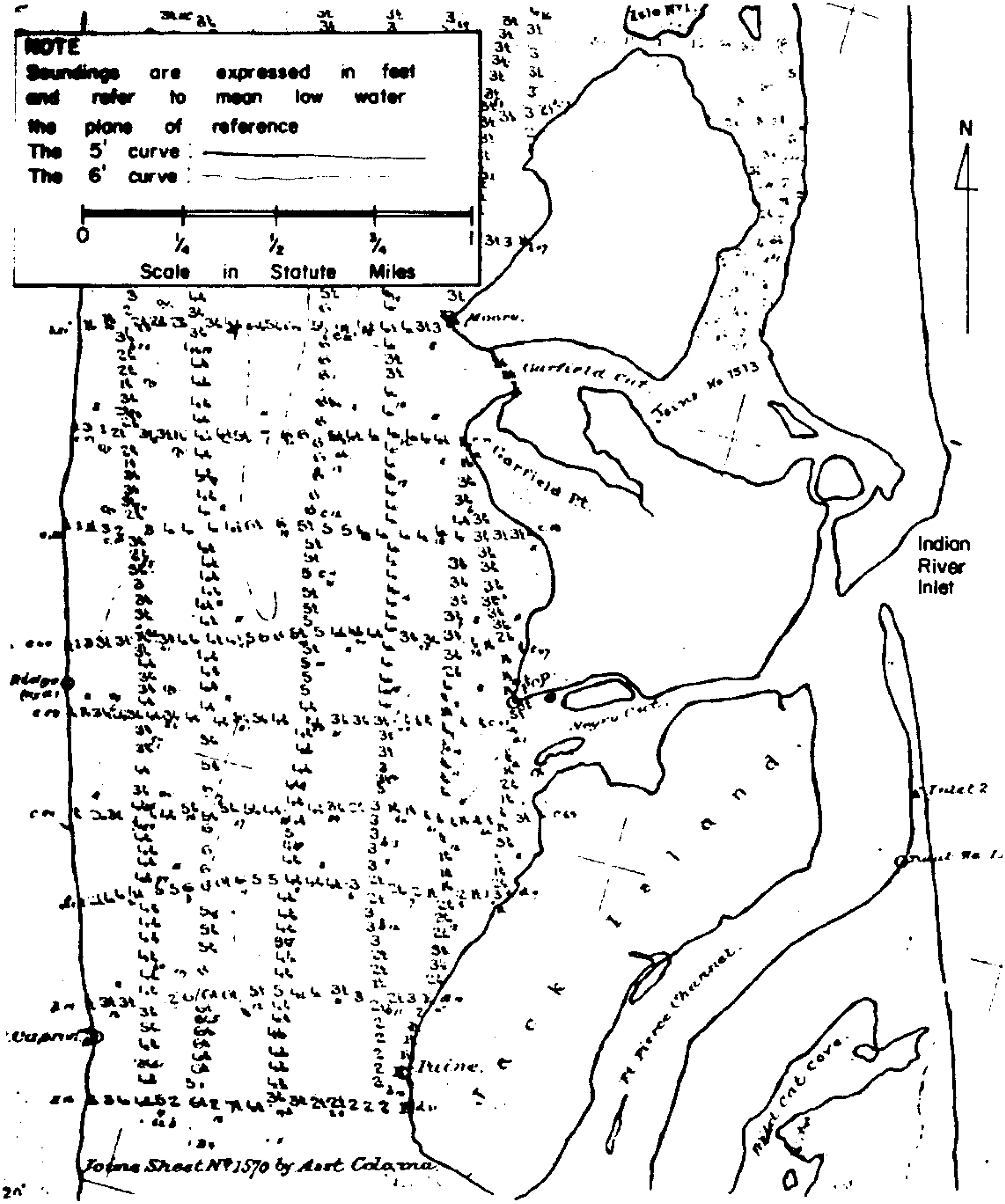


FIGURE A2 OLD INDIAN RIVER INLET.
PORTION OF NATIONAL OCEAN SURVEY (U.S.C.&G.S.) CHART
H 1513b SURVEYED MAY 2-9, 1883

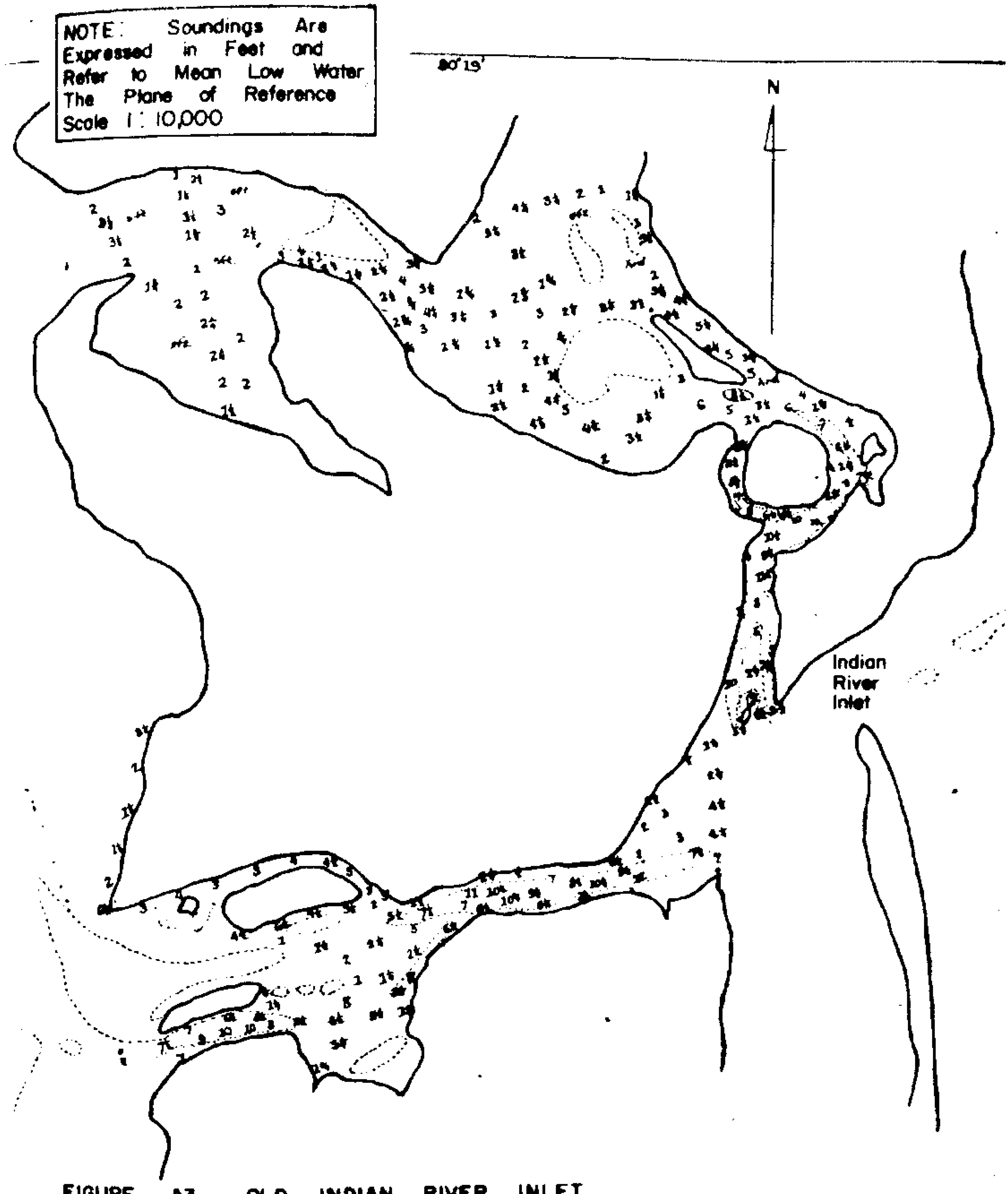


FIGURE A3. OLD INDIAN RIVER INLET
PORTION OF NATIONAL OCEAN SURVEY (U.S.C.&G.S.) CHART H 1513b, Surveyed May 2-9, 1883

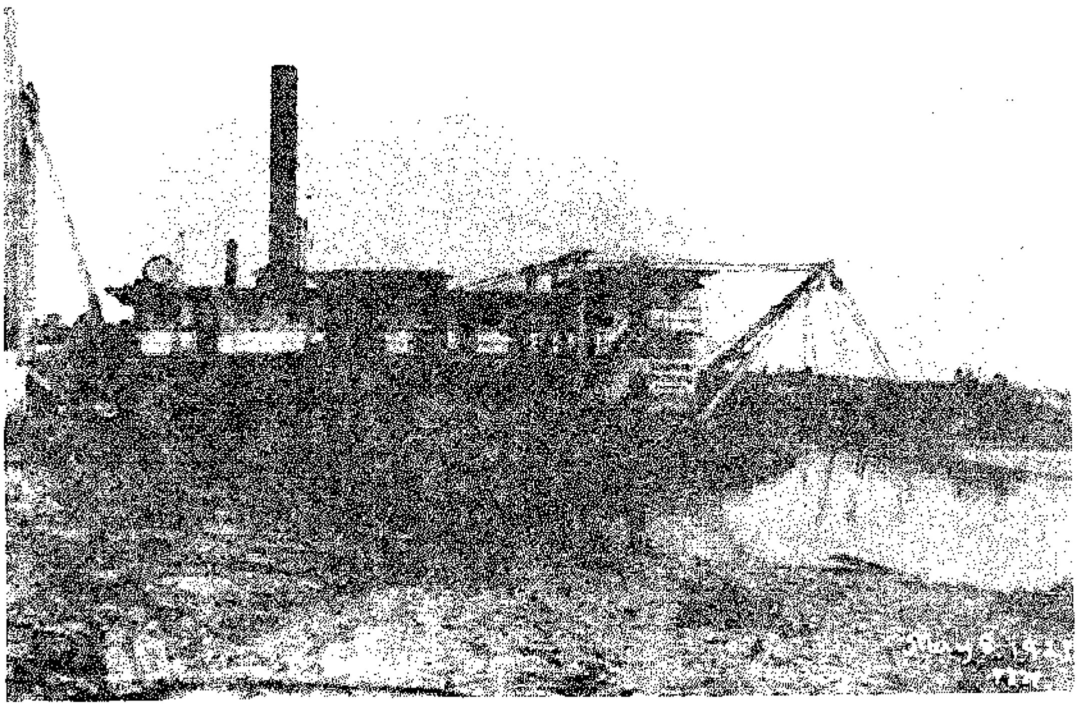


FIGURE A4 PIPELINE HYDRAULIC DREDGE TUSCAWILLA CUTTING THE FORT PIERCE INLET MAY 8, 1921 (FURNISHED COURTESY OF COL. M. A. RAMSEY, FT. PIERCE, FLA.)

FIGURE A5a FORT PIERCE INLET PRIOR TO FINAL CUT THROUGH BARRIER. MAY 8, 1921

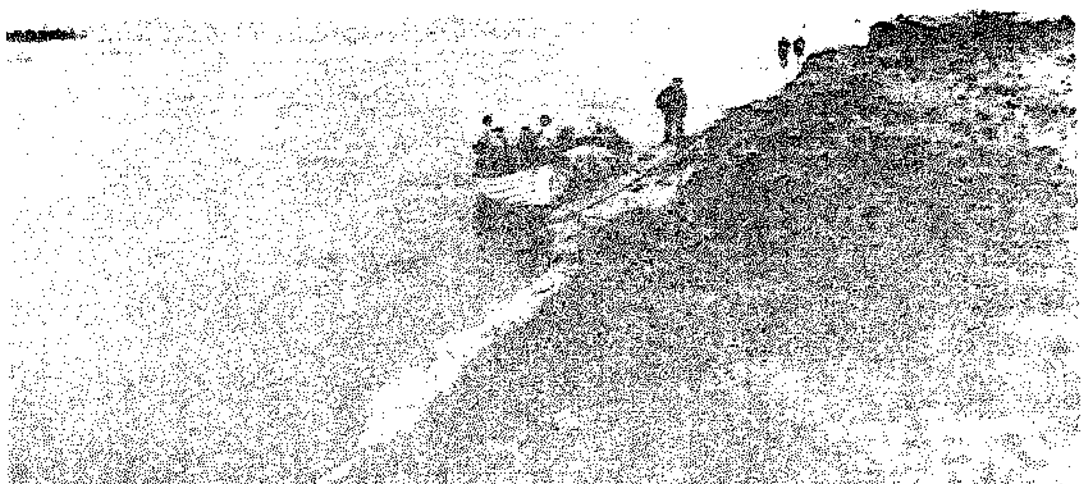


FIGURE A5b FORT PIERCE INLET AFTER THE FINAL BARRIER CUT. MAY 9, 1921
(FIGURES 5a, 5b FURNISHED COURTESY OF COL M. A RAMSEY, FT. PIERCE, FLA.)

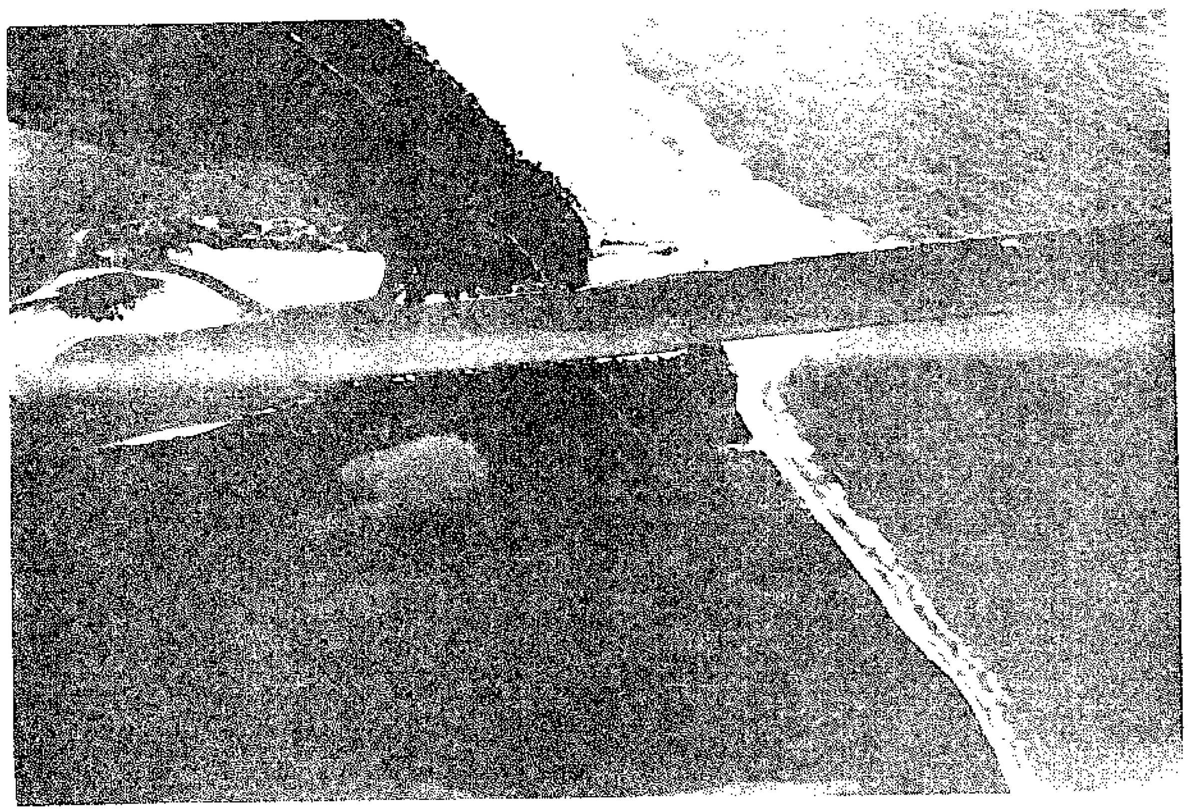
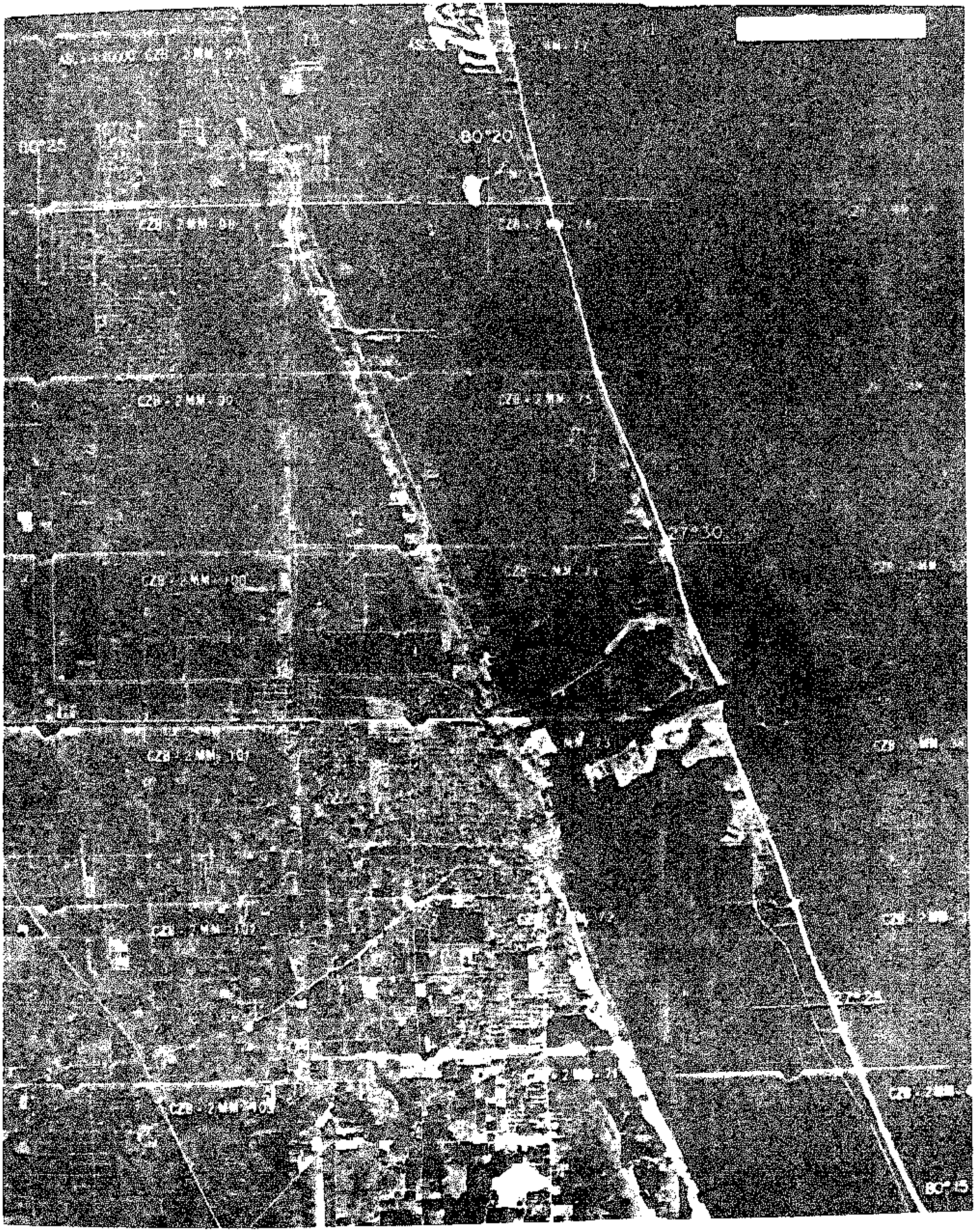


FIGURE A6 OBLIQUE AERIAL PHOTO OF FORT PIERCE INLET. 3-18-36


80°20'
27°30'

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This public document was promulgated at a cost of $264.02, or 66 cents per copy, to provide current information to persons interested in the management, use, and control of Florida's coastal inlets.

This is the second Report published by the State University System of Florida Sea Grant Program. These are semi-technical to technical publications and are numbered consecutively beginning with Report Number 1. The publication, "Research and Information Needs of the Florida Spiny Lobster Fishery," published in April 1974 and numbered SUSF-SG-74-201 is renumbered Sea Grant Report Number 1 and becomes the first in this series. Report Number 2 is entitled: "St. Lucie Inlet - Glossary of Inlets Report #1."